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(Continued from p. 123)

Afternoon Session, Friday, December 27, 1918, 2.40 p. m.

VICE-PRESIDENT E. C. COTTON: The next paper on the program is entitled, "Important Insect Pests Collected on Imported Nursery Stock, 1918," by Mr. E. R. SASSCER.

IMPORTANT FOREIGN INSECT PESTS COLLECTED ON IM- PORTED NURSERY STOCK IN 1918

By E. R. SASSCER

The amount of nursery stock offered for entry into the United States during the fiscal year 1918 showed a marked decrease as compared with former years. Especially is this true of the five principal exporting European countries,¹ which showed a falling off of some 22,953,147 plants. The number of plants exported by these European countries for the fiscal year 1918 was as follows:

England.....	1,865,539
France	16,767,673
Holland.....	2,016,884
Belgium and Germany.....	

In other words, France alone exported more stock to the United States in 1913 than all these countries in the fiscal year 1918. A summary of the plant imports for the fiscal year ending June 30, 1918, is

¹ The amount of stock exported by these countries from 1913 to 1917, inclusive, is given in previous lists of important foreign insect pests, etc., published in the JOURNAL OF ECONOMIC ENTOMOLOGY.

given by Mr. C. L. Marlatt, Chairman of the Federal Horticultural Board, in his report to the Secretary of Agriculture of September 30, 1918.

Notwithstanding the falling off of importations of plants, dangerous insects have continued to enter on nursery stock. As these pests are listed in the Quarterly Letters of Information of the Federal Horticultural Board, copies of which are available to all inspectors, it is only necessary to refer to the insects which appear to have potentialities, if they become established and widely distributed in this country.

The pink bollworm (*Pectinophora gossypiella* Saunders) has been collected on two occasions in shipments of cotton from Brazil. In one instance, some 1,992 bags of cotton arrived at New York in violation of the cotton regulations, and, as a result, were returned to the port of origin, where, according to the Department of State, the entire shipment was destroyed by the Brazilian Government, on account of this infestation. The second shipment, consisting of about a pound of infested cotton seed, was sent to the Department of Agriculture, and, after a thorough examination, destroyed by fire. The sorrel cutworm (*Acronycta rumicis* L.), which was referred to in the last list of important foreign insect pests, has again been collected, in the pupal stage, on miscellaneous plants from France. From European literature, it is apparent that this insect is an omnivorous feeder, and its entry into and establishment in this country should be prevented, if possible.

A shipment of rhododendrons from Holland was found to be lightly infested with larvæ of *Chimabacche fagella* Fab., an insect reported to be injurious to the foliage of oak, beech, and birch in northern and eastern Ireland. Judging from the available literature on this insect, it is apparent that it is primarily a forest and shade-tree pest, and its occurrence on rhododendrons may possibly be accidental; although at the time of examination there was abundant evidence of foliage injury. The larvæ of the swan or gold-tail moth (*Porthesia similis* Fuessl) were collected on Japanese maple from Holland and on *Cerasus avium* from France consigned to Pennsylvania. One hundred and ninety-four nests of the fruit-tree Pierid (*Aporia crataegi* L.) were collected by New York state inspectors on several shipments of deciduous fruit tree seedlings from France. The fruit tree Pierid is another European insect which is known to be a general feeder, having thus far been recorded as devouring the foliage of fruit trees, wild rosaceous plants, and deciduous shade trees.

The azalea leaf miner (*Gracilaria zachrysa* Mey.) has been taken on eight shipments of azaleas from Holland. Nests of the brown-tail moth (*Euproctis chrysorrhæa* Linn.) were collected on ten shipments of miscellaneous plants from France, and egg masses of the gipsy

moth (*Porthetria dispar* Linn.) were taken on two shipments of French stock.

The lesser bulb fly (*Eumerus strigatus* Fallen), together with the narcissus fly (*Merodon equestris* Fab.), was collected in considerable numbers in narcissus bulbs from Holland. The lesser bulb fly was also submitted for identification by one of the seed firms of Philadelphia, with a note that the larvæ were taken from Holland-grown narcissus bulbs. This bulb insect is known to be established in the states of California, Washington, Colorado, Ohio and Maine. Although the economic status of the lesser bulb fly is in dispute, Verrall¹ says the European *E. strigatus* has been bred from bulbs of the common onion (*Allium cepa*) of which they sometimes destroy a whole crop.

Seeds of the wild cherry (*Cerasus avium*) from France were found to contain a number of dead adults of *Anthonomus rectirostris* L.² This weevil in Europe is known to feed in the pits of *Prunus* and *Cerasus*. Inasmuch as tons of cherry and *Prunus* seeds have been introduced into the United States in the past, a large percentage of which were never inspected or fumigated, it is remarkable that this insect has not been introduced into and established in the States. Of course, there is a possibility that it is established in isolated localities and has not been recorded. Sugar-cane entering California from the Hawaiian Islands was found to be infested with the sugar-cane borer (*Sphenophorus obscurus* Boisd.). Avocado seeds from Guatemala have continued to arrive infested with larvæ of an undescribed species of *Conotrachelus* and an unrecognized *Stenomacrus*. The larvæ of both of these insects are responsible for considerable injury to the seed, and, according to Mr. Wilson Popenoe, who has spent considerable time collecting these seeds in Guatemala, this lepidopterous insect is perhaps one of the most injurious avocado pests now established in Central America.

As usual, a number of scale insects have been intercepted on incoming stock; the more important ones being an undescribed species of *Solenococcus* on avocado cuttings from Guatemala³, the European peach scale (*Lecanium persicæ* Fab.) on *Fontanesia* and *Berberis purpurea* from France and on peach from England, *Parlatoria chinensis* Marlatt on two species of *Pyrus* from China, and *Lecanium coryli* Linn. on an undetermined host from England.

VICE-PRESIDENT E. C. COTTON: Is there any discussion of this paper?

MR. R. C. OSBURN: Mr. Chairman, I should like to report the occurrence of *Eumerus strigatus*, the bulb fly, at Columbus, Ohio, last

¹ *British Flies*, Vol. 8, p. 615, 1901.

² According to Dr. W. Dwight Pierce, *A. druparum* L. is a synonym of *A. rectirostris* L.

spring. I tried to trace up the origin of these, thinking that if they came from the onion I would certainly be able to follow up the scent, but I was not able to find where they came from. However, I hope they have not located there permanently.

VICE-PRESIDENT E. C. COTTON: The next paper is "Organization for Insect Suppression," by Mr. A. F. Burgess.

ORGANIZATION FOR INSECT SUPPRESSION

By A. F. BURGESS, *Melrose Highlands, Mass.*

With the reconstruction and rearrangement of activities which must necessarily accompany the period immediately following the Great War, it seems timely to consider briefly what methods and organizations have proved workable and satisfactory when applied on a large scale. It is not the purpose of this paper to deal with insect suppression which may be handled along the lines of extension work, although it is possible that some of the ideas conveyed may be applied directly to the management of these activities.

For over twenty years the entomologists of the United States have been face to face with serious insect problems. Some have been local while others were general in their scope. During the first part of this period little organization seemed necessary, as the workers were few in number and the importance of the problems was not brought home to the public and emphasized enough so that their full meaning was appreciated.

Twenty years ago the Jersey mosquito was a standing joke. It was considered by the public as one of those nuisances that must be endured and very few entomologists were courageous enough to boldly advocate exterminative measures on a large scale. Careful investigations of the habits of the mosquito family brought to light the serious menace of permitting these insects to continue their increase unchecked, and today public opinion recognizes that they are not only obnoxious on account of their irritating habits but that some of the species are positively dangerous because of their ability to spread disease. The same is true of many other insects which annoy and make life uncomfortable for man and beast.

It cannot be claimed that control measures have been put into operation, except possibly over limited areas, that have completely relieved this undesirable condition; but when we compare present conditions with the apparent hopelessness of the situation twenty years ago, we must conclude that progress has been made.

No insect, up to the present time, has caused such widespread con-

sternation among the fruit-growing interests as the San José Scale, and as a result of its introduction and spread throughout the nation, practically every state has passed laws relating to its control as well as that of other serious pests. It is not an item of news to the members of this association to call attention to the diversity of laws, of regulations and of forms of organizing the work which resulted from the danger of the unrestricted spread of this insect. Repeated attempts were made to secure Federal legislation in order that problems of controlling dangerous pests might be handled with more uniformity, but these attempts failed until the Plant Quarantine Act was passed by Congress in the summer of 1912. Since that time attempts have been made to secure uniform state legislation, but so far as is known to the writer, little success has resulted along this line. Inasmuch as proper organization of work of this character usually is based on State or Federal law, careful attention should be given to have the statutes carefully drawn.

Never within the memory of the present generation has the food situation been so pressing as during the past two years, or have the people been obliged to conserve their resources so extensively, and never has there been a time when National and State indebtedness has mounted so high. This is bound to have a direct influence on future taxation and future prosperity. It would therefore seem fitting for the entomologists to place their houses in order against the time when retrenchment will be the order of the day, and reconstruct and regroup their activities so as to secure maximum results.

Insect suppression naturally falls into two classes, viz: The control of insects that are widely distributed throughout the country and control of newly established pests which are present in a limited area.

The methods used in the former class must necessarily be suited to the local conditions and in many cases they cannot be standardized, and the form of successful organizations for carrying on the work must be adapted to these conditions. Better results might be obtained, however, by closer acquaintance of the officials engaged in the work and a more thorough understanding of the problems and difficulties with which each has to contend. Meetings like this should pay large dividends in increasing efficiency if all could attend, but many of the authorities concerned do not take steps to make this possible.

This will not accomplish all that should be undertaken. There should be closer relations established between the State and Federal authorities that are mutually interested in these matters and a constant effort should be made to strengthen these relations. Spasmodic efforts for improvement are not likely to be successful and if this work is to be left to individuals who are already overburdened with other

duties, or to committees who have neither the time nor wide knowledge of the conditions that exist throughout the country, little of permanent value is likely to result.

Some office in the Bureau of Entomology or in the Federal Horticultural Board should make a special study of these matters and after becoming acquainted with all the details of the problem should make an attempt to bring about better conditions. It is needless to say that such a task calls for experience, skill, and the utmost tact, and that improvement along these lines cannot be hastened by using a club. Perhaps a committee of this association could cooperate to advantage along these lines.

In the control of introduced pests the problem is quite different. During recent years the Federal Government has recognized its responsibility in this direction and an increasing amount of work is being done.

The control or extermination of introduced pests present many difficult problems. In the first place the insect must be of great economic importance and the necessity for active work must be well recognized if it is to gain public support. It is impossible to accomplish results unless adequate funds are provided. If a skyscraper is to be constructed the judgment of the architect is respected or he drops the job. You cannot build a \$10,000 house for \$2,000 and few people have the hardihood to attempt it. Yet it is not uncommon to see an entomologist attempting to solve far more intricate and difficult problems in insect suppression with financial support which he and every one else knows is inadequate. He tries to build the \$10,000 house and if perchance he is fortunate enough to lay the foundation with the funds at his disposal, he congratulates himself that something has been accomplished, excuses the incompleteness of the work as best he can and endeavors to secure more support in order to add another installment to the structure before the ravages of time undo the work that has already been done.

The results of this method are far-reaching. Because of inadequate funds and superabundance of work, it is impossible to give the close study to all the details which are necessary if the best results are to be secured. There is also the tendency to secure quantity rather than quality when assistants are employed and this must often be done because the funds are not available for a sufficient number of the best experts. Under present conditions there is small inducement for young men to specialize in entomology. When the expert can secure little more than the untrained laborer, men of ability will naturally seek those fields of employment where fair pay and the reasonable comforts of life can be secured. If the most competent men are to be obtained to

attempt the difficult and perplexing problems of insect suppression, compensation commensurate with the importance of the tasks must be forthcoming.

The strongest and most effective organizations in this country recognize these facts and act accordingly.

On the other hand, unsatisfactory results may be secured when ample funds are provided if care is not taken in properly organizing and directing the work. Experience, skill and good judgment are required to bring about the desired results and if these are lacking disappointment will follow.

Plainly stated, the essential features of any problem of this sort are to determine all the facts covering the life and habits of the insect concerned, the kind of food that it requires, the damage likely to result, the means of spread, the effectiveness of natural agencies, and the best field treatment to bring about its control.

These may be grouped under the head of experimental work, the most important phases of which should be given the greatest prominence; field work to determine the territory that is infested and to apply new control measures and quarantine to prevent the spread of the species by inspection, fumigation or otherwise.

Each of these phases of the work should be organized and the details of methods worked out to fit the problem at hand. This will prevent duplication of effort and make it possible to transfer men to projects where they are most needed. If the problem is a large one this can be accomplished by centralizing the control of the work, so that overlapping can be avoided, misunderstandings be quickly adjusted and arrangements made with the State Officials and other agencies in touch with the work.

Five years' experience with the method of organization indicated above, which was adopted for handling the gipsy moth work by the Bureau of Entomology, has demonstrated its value. On such a large problem where 200 or 300 men are employed and work is often carried on in several states at the same time, centralization is imperative if the best results are to be secured. Where a large force is employed, a system of reports and constant field supervision is essential if the full value of the money expended is to be realized. A plan along the same general lines is practical on a smaller scale. To illustrate the usefulness of this method a few cases may be cited. Several years ago it seemed desirable to determine whether the introduced parasites of the gipsy moth were attacking native injurious insects. Experimental work had shown that some of these parasites passed through their spring generation on the gipsy moth but it was necessary for them to have a summer or fall host, otherwise the later broods of the parasites

would perish. Accordingly a plan was made to secure collections of native lepidopterous larvæ each summer from as many localities within the gipsy moth infested area as possible. The necessary instructions concerning the kinds of collections desired, and the information to be recorded by each collector was sent to each foreman and inspector throughout the territory and some of the State officials were interested to forward material. This arrangement was worked out in detail. The men were supplied with shipping boxes and mailing tubes and these containers were promptly returned to them as soon as they were emptied at the laboratory. In midsummer we have frequently received by mail fifteen containers daily with this class of material alone. As a result of this opportunity to utilize the services of these men without interfering with their regular duties, a large amount of valuable data has been secured from a territory which covers about one-half the area of the New England states. Incidentally an enormous number of records of parasitism by native Hymenoptera and Diptera have been obtained and as this work is carried on year after year, the facts concerning the increase or decrease in abundance of the native insects in this region together with similar facts as to their parasites will be extremely useful.

It has been found desirable to secure accurate records of temperature and humidity from a number of selected localities for use in connection with some of the experiments. Self-recording instruments which require attention weekly have been installed and in many cases these are attended to by inspectors or foremen without interfering with their regular work.

If special information is desired from any part of the area, it can usually be obtained without delay or friction by utilizing men who are employed by some section of the work. This arrangement is valuable in saving time, effort and money, and also serves to increase the interest of the men in the work as a whole.

Perhaps it may not be out of place to add that it takes more than a system to make any organization successful. One of our ex-presidents of the United States, when addressing a class in Civil Government at Harvard University a number of years ago, stated that anyone could devise a good system of government but that it takes a smart man to make it work. Many of the best laid plans of work fail because of the ever present human element which is often the dominant factor.

Any enterprise in insect suppression cannot be successful if this fact is ignored. If men are assigned to do those things for which they are best qualified and in which they are most proficient, much will be accomplished. The misplaced man is dissatisfied both with himself and his job and is a prolific source of discontent in any institution.

The success of most problems in insect suppression work rests principally on good business management and entomologists should not be slow in recognizing this fact.

VICE-PRESIDENT E. C. COTTON: This completes the program of the horticultural inspectors.

In the absence of the President, I will call for the next paper,

THE MORPHOLOGY, BEHAVIOR AND SUSCEPTIBILITY OF THE EGGS OF THREE IMPORTED APPLE PLANT LICE

By ALVAH PETERSON, *New Brunswick, N. J.*

(Withdrawn for publication elsewhere)

VICE-PRESIDENT E. C. COTTON: The paper is open for discussion now.

MR. P. J. PARROTT: As I understand the speaker, you make the application of lime sulphur solely to destroy the eggs.

MR. ALVAH PETERSON: No, because at that period the eggs are hatching and the combination will kill the nymphs and the eggs.

MR. P. J. PARROTT: In New York we are advising our farmers to hold back the spraying, because we aim at the nymphs.

MR. ALVAH PETERSON: In New Jersey the eggs have not all hatched at a time when we apply the material. *Aphis avenæ* in our state hatches ten days before *Aphis sorbi*. To wait until the eggs are all hatched would be too late.

MR. C. P. GILLETTE: Through how long a period did you find the eggs of any one species hatching normally?

MR. ALVAH PETERSON: Ten days—usually less than that. If you have a warm spell during the hatching period, they will hatch in four or five days, but if it is cold and wet the hatching period may extend over a period of ten days for one species.

MR. P. J. PARROTT: In your field experiments, when the trees have been thoroughly sprayed at the time indicated by your third picture, did you have any difficulty in getting complete killing of the insects?

MR. ALVAH PETERSON: I can give you an example of that in one orchard where the man was very thorough in his work. We tried the nicotine combined with the lime sulphur, and even though this man was very thorough in his work, he did not get 100 per cent. Our experiments also showed that the eggs of *Aphis sorbi* and *pomi* are not as susceptible to sprays as *avenæ*.

MR. P. J. PARROTT: But you are making that recommendation?

MR. ALVAH PETERSON: Yes, because it is the best recommendation we have, so far as we know at the present time.

MR. W. J. SCHOENE: The hatching of these eggs and the appearance of the aphids have been noted for several past seasons, not only by the entomologists but also members of the other departments. The fact has been noticed that the eggs hatch many weeks in advance of the time when the buds show green at the tips. We found them late in February and early in March, when the aphid had no chance to obtain food.

MR. ALVAH PETERSON: What species?

MR. W. J. SCHOENE: *Avenæ*.

MR. R. C. OSBURN: I would like to ask Dr. Peterson whether his observations indicate that *avenæ* is of any importance in getting out the test? What experiments have you to show that the nicotine should be used one to four hundred, as against one to nine hundred? The bulk of the United States probably uses nicotine sulphate at the rate of three quarters of a pint to one hundred gallons, and it would be very interesting to know why New Jersey reduces the recommendations to one to four hundred?

MR. ALVAH PETERSON: In the first place I might say that our recommendation is one to five hundred.

In respect to the difference in the amount of injury done by the various species, of course that which is done by the *avenæ* is least of all. I fully expect to see injury done by *avenæ* this coming spring for they undoubtedly will be abundant, because I know of one orchard today in New Jersey where the eggs are actually so abundant that you cannot touch a square inch of the large trunk of the tree without crushing a number of eggs. When these eggs hatch and come out and attack the young, green buds, it stands to reason that there will be some injury, even though it may not be as marked as that of *sorbi* or *pomi*.

In respect to one to five hundred or one to a thousand, or whatever might be recommended in using nicotine sulphate, I might say that we do not get as good a clean-up with one to a thousand as we do with one to five hundred. Mr. Barclay carried on experiments in his orchards with one to five hundred and one to a thousand, which showed conclusively that one to five hundred is much better. Dr. Headlee has carried out some experiments along that same line. Probably he could give you some pointers on this.

MR. T. J. HEADLEE: We have been interested in the study of the control of the apple aphid for three or four years, and we were lead to take it up because of the failure of some of our orchardists to obtain protection by the application of nicotine at the cluster cup or pink bud

spray.. The same year that this failure occurred we made a laboratory test to determine the minimum dosage which would destroy the rosy aphid. At the time the test was made the rosy aphid was present in all stages from the slaty colored stem mother to the winged forms. The results of that test are shown in the following table:

EFFECT OF NICOTINE SPRAYS ON ROSY APHIS

Number of Leaves	Treatment	Percentage Living at End of Experiment
2	Water only	100
2	"Black Leaf 40" (1 part) + water (900 parts)	60
2	"Black Leaf 40" (1 part) + water (900 parts) + soap (2 lbs. to 50 gal.)	10
2	"Black Leaf 40" (1 part) + water (700 parts) + soap (2 lbs. to 50 gal.)	1
2	"Black Leaf 40" (1 part) + water (500 parts)	10
2	"Black Leaf 40" (1 part) + water (500 parts) + soap (2 lbs. to 50 gal.)	0

The following year we laid out some blocks of seven-year-old apple and made the series of treatment indicated in the following table:

SUMMARY OF RESULTS IN APHIS CONTROL EXPERIMENT

Plot Numbers	Treatment	Total Number of Buds Examined	Total Number of Aphids Found	Number of Aphids Per 100 Buds
1 & 1	Lime-sulfur (1 to 9) during dormancy; "Black Leaf 40" (1 to 1,000) + soap (2 lbs. to 50 gal.) when buds showed green	281	5	1.7
2 & 2	Lime-sulfur (1 to 9) during dormancy; lime-sulfur (1 to 9) + "Black Leaf 40" (1 to 1,000) when buds showed green	282	18	6.3
3 & 3	Lime-sulfur (1 to 9) when the buds showed green	329	304	95.
4 & 4	Lime-sulfur (1 to 9) + "Black Leaf 40" (1 to 500) when buds showed green	339	11	3.2
5 & 5	Lime-sulfur (1 to 9) + "Black Leaf 40" (1 to 1,000) when buds showed green	331	156	47.1
6 & 6	Scalecide (1 to 15) while buds were dormant	306	37	12.
7 & 7	Scalecide (1 to 15) when the buds showed green	303	9	2.9

NOTE.—Unsprayed trees showed average of 600 aphids per 100 buds.
A large block of trees of the same age and variety in the same orchard were sprayed with lime-sulfur (1 to 9) during dormancy. These trees showed an average of 6 aphids to 100 buds.

Mr. John Barclay of Cranbury was the orchardist coöperating and the man who personally made the treatments. Throughout my entire experience I have never seen an orchardist or an entomologist who made treatments any more thoroughly than Mr. Barclay and I believe therefore that the data obtained are reliable. This table shows that the spray of winter-strength lime-sulphur to which 40 per cent nicotine was added at the rate of 1 to 1000 left fifteen times more living aphids

on the tree than the spray composed of winter-strength lime-sulphur to which 40 per cent nicotine was added at the rate of 1 to 500. No man can say without a foreknowledge of the weather what degree of reduction will constitute a control. It is therefore advisable to obtain the greatest degree of reduction possible, and the mixture of winter-strength lime-sulphur to which 40 per cent nicotine has been added at the rate of 1 to 500 appears to give a much greater reduction than the less strengths of nicotine.

PRESIDENT E. D. BALL: I will now call for the next paper by Mr. A. L. Quaintance.

MR. A. L. QUAINANCE: I wish to explain that I prepared no paper. When I saw that there were already on the program papers dealing with the Japanese beetle and oriental fruit moth, it appeared to me preferable to discuss and perhaps elaborate on the papers presented, if opportunity offered, rather than to present another formal paper. Unfortunately I missed hearing the papers presented by Professor Cory and Mr. Goodwin, but have no doubt that the subjects were fully covered. There are two or three questions relative to quarantine measures, however, and the question of possibility of the eradication which may be of interest to some of the membership. The quarantine question is, of course, in the hands of the state entomologists concerned. As to the eradication of the oriental fruit moth and Japanese beetle, I would say that in my opinion while such eradication is of course within the realms of possibility, provided large funds are available and very drastic measures are adopted, yet I doubt the feasibility and expediency of a program of this character.

Perhaps all of these questions have been discussed by Mr. Goodwin and Professor Cory and I would not wish to repeat anything since we have still before us a very interesting program. It is suggested therefore that unless there are particular questions in which members are interested that further time be not taken up with this subject.

MR. P. J. PARROTT: We people from other parts of the country do not often have the opportunity of seeing Mr. Quaintance, much less to hear him, and I would like very much to have him discuss both of these insects and give us his impression of the situation.

MR. A. L. QUAINANCE: Referring first to the Japanese beetle: We do not know, of course, how much of a pest the Japanese beetle is going to be. While the adults attack a large variety of food plants, some of which are injured to an important extent, it is very probable that such damage can be effectively checked by the use of arsenical poisons sprayed or dusted over the plants being injured. The beetles feed upon numerous ornamentals which are now, as a rule, but little sprayed, but which for the most part could readily be sprayed without

unduly complicating their profitable cultivation. We are quite uncertain as to the amount of damage to expect from the larvæ attacking the live roots of plants. This type of injury, if important, would probably prove difficult of correction.

I think entomologists are warranted in assuming that a newly introduced insect will become a troublesome pest and arrange their work on that basis. A change of policy, of course, can be adopted as soon as it is clear that the insect in question will not be especially troublesome. Acting on this plan the Bureau of Entomology, coöperating with Dr. T. J. Headlee, New Jersey State Entomologist, has undertaken work looking toward the eradication and control of the insect. Mr. Goodwin doubtless fully explained to you this morning the character of field work now under way. If its eradication cannot be accomplished, our efforts, it is hoped, will result in restricting its spread until its economic status will have been better determined.

Our inspection records for 1917 of the distribution of the Japanese beetle were not very extensive, and while we have been able to make fairly thorough inspecting during 1918, we are unable to decide on account of the uncertainty of the thoroughness of previous inspection work, whether the insect is spreading rapidly, moderately or not at all. Personally, I am of the opinion that it spread during 1918 to a considerable extent.

Several state entomologists have made inquiry concerning what quarantine measures, if any, should be undertaken to prevent the introduction of the insect into their states. I think it would be dangerous to permit the shipment from the infested area of plants with soil around the roots. I understand that Dr. Headlee has in effect regulations to prevent the movement of such plants. There is danger also of the distribution of the beetles in green, sugar or field corn, since the beetles freely penetrate the tips of the ears of green corn to feed upon the milky kernels. The danger of the spread of the insect in this way seemed so important that a quarantine of green sweet corn was established by the Federal Horticultural Board, effective June 1, 1919, and adequate machinery will be provided for the inspection, certification and movement of this crop.

Several things interfered with the vigorous prosecution of the field work planned for 1918, as insufficient funds, difficulty in obtaining in time machinery and insecticides, and difficulty in obtaining labor. We hope to surmount all of these difficulties next year and feel that 1919 and 1920 will be our big years in the work, and which will prove conclusively what can be hoped for towards the eradication of the Japanese beetle.

The establishment in the United States of the oriental fruit moth has

awakened a good deal of interest among entomologists and fruit growers. It may be that possibilities for injury by this insect have been over-emphasized. There is, however, considerable reason for fearing that the insect may become a first-class pest of deciduous fruits. It belongs to the same genus with the codling-moth. There are developed in the latitude of Washington four or five broods of larvæ each year, and the behavior of the insect in orchards coming under the speaker's observation leaves no doubt as to the capabilities of the insect for harm. Notwithstanding all of these facts the oriental fruit moth may, of course, succumb to the action of native parasites, or for other reasons fail to develop into a serious pest, a result which is much to be hoped for.

Funds were available under the appropriation for stimulating agriculture to make a rather thorough survey of the United States to determine the distribution of the insect. There were employed at one time or another some fifteen or eighteen inspectors, and while it was possible to inspect only the more important fruit-growing regions, yet the scouting was so arranged that had the insect been generally scattered over the country, it would have certainly been detected. Inspections were made of the peach belt of the South and representative peach and apple orchards were inspected in the middle Atlantic States, the middle West, the Rocky Mountain States and the Pacific Coast. Briefly the insect was found to occur only in a strip of territory that may be said to border on each side of the railroads between Washington and New York. In the environs of Washington, we have a rather severe infestation extending a few miles south into Virginia and northwestward to about Leesburg, Va., where large commercial peach orchards are located. The insect is pretty well present over southern Maryland, extending northward through Frederick and Washington Counties, Md. There is an infestation at Lancaster, Pa., and it has been taken in the environs of Philadelphia. Northern New Jersey is more or less infested, and the insect is rather generally present on ornamental and other *Prunus* spp. on Manhattan and Long Islands. There is an infestation in southern Connecticut and extreme southern New York.

Considerable difference of opinion prevails among entomologists as to the practicability of quarantine measures in the restriction of spread of this species, and perhaps something should be said on this subject. It should be borne in mind that the oriental fruit moth infests fruit, especially peaches, apples, pears and quinces and also the tender tips of nursery stock and orchard trees, particularly the peach. We may fairly judge of the probable effectiveness of quarantine measures in preventing the spread of the oriental fruit moth in fruit by what we know of the value of such efforts in preventing the spread of the codling-moth. In the case of an insect infesting fruit any adequate inspec-

tion and certification as to freedom from the insect would be exceedingly difficult to arrange, and would require a large force of inspectors and funds to make the work reasonably efficient. Even under such a system it is practically certain that the pest would gradually be disseminated in spite of all efforts to the contrary. A more logical plan would appear to be to provide for the inspection of orchards and quarantine movement into non-infested areas of fruit from orchards found to be infested.

In the case of nursery stock, the danger of distribution in the speaker's judgment is slight. Of course it is possible that some of the larvæ might still be in the tips of the twigs when the trees are dug and shipped in early fall, but in the case of nursery stock handled in the usual way, larvæ in most cases would have deserted the twigs and sought suitable places for the construction of cocoons in which to hibernate. Probably only in rare instances would the cocoon be found along the trunk of the little nursery tree, but more likely on the ground under accumulated trash, etc. Any quarantine plan to be effective, therefore, should pay especial attention to restricting the movement of infested fruit, the quarantine on nursery stock being merely incidental. In view of the extreme difficulty, if not impossibility, of restricting the spread of this insect by quarantine measures, such quarantines are, in the speaker's opinion, of doubtful utility and should receive the careful attention of state entomologists before being put in effect. Surely coöperation among state officials should be had and a uniform policy adopted, if possible.

In states where peach growing is now a large and specialized industry, as in portions of the South, the Alleghany States, the Pacific Slope and elsewhere, the officials charged with the protection of these industries from introduced insect pests will no doubt give careful consideration as to what should be done under the circumstances, considering in this connection the extreme difficulty of putting in operation measures which would really prevent the movement of the pest in fruits.

It is pretty certain that the oriental fruit moth will not be very troublesome to apple growers, since the methods of control employed for the codling-moth should also secure the control of this insect. In the case of peaches, however, the situation is not so favorable, since owing to the habits of the pest, it will be very difficult to materially control it by sprays, judging from results of experimental work along this line thus far carried out.

MR. J. G. SANDERS: I would like to ask Professor Quaintance whether he thinks it possible or probable that European authorities may quarantine against American apples on account of this insect.

MR. A. L. QUAINANCE: That is a question I cannot answer. I

think European authorities have very rarely quarantined against American fruits on the grounds of danger of introduction of injurious insects. It is true that the German Empire and one or two other governments quarantined American apples on account of the San José scale. It is my understanding, however, that in the case of Germany this quarantine was not issued so much on account of the San José scale as to favor growers of apples in that country. Personally, I do not believe Europe will quarantine against the oriental fruit moth.

MR. T. J. HEADLEE: We do not want any misconception concerning the measures that are taken to prevent the distribution of the Japanese beetle on nursery stock into other parts of the United States. From the time the existence of this insect was recognized no plants have been allowed to leave the infested sections of the nursery without having all the soil removed from the roots. In view of the fact that the plants are moved when the Japanese beetle is in the ground as a grub, such precautions would seem ample to prevent the distribution of the insect on nursery stock.

MR. E. N. CORY: You don't attempt to control the action of the individual in taking plants out of the areas?

MR. T. J. HEADLEE: In response to Mr. Cory's question, up to the past season we have made no attempt to prevent individuals from carrying in hand, bag or vehicle, individual plants such as rosebushes from premises within the infested area. During the past season a campaign of education was put on among the people living in the infested district for the purpose of obtaining their coöperation in the prevention of this sort of movement. During the coming year still greater and we hope more effective efforts will be taken along this line.

PRESIDENT E. D. BALL: The next paper is entitled "High Temperature Fumigation and Methods of Estimating Radiation Required," by W. H. Goodwin.

HIGH TEMPERATURE FUMIGATION AND METHODS OF ESTIMATING RADIATION REQUIRED

By W. H. GOODWIN, *New Brunswick, N. J.*

(Withdrawn for publication elsewhere)

VICE-PRESIDENT W. C. O'KANE: The next paper on the program is "The Potato Leaf Hopper," by E. D. Ball.

THE POTATO LEAFHOPPER AND ITS RELATION TO THE HOPPERBURN

By E. D. BALL, Ames, Iowa

The leaves of the potatoes were badly burned during the season of 1918 all over the whole northern part of the United States, from Montana to New York, and New Jersey south to Kansas and Ohio. In different places it was called "blight, tipburn, or aphid work." The writer's attention was called to it on July 17. At this time the early potatoes in southern Wisconsin were largely dying or dead from the trouble. On examining the injured plants it was found that the leaves with only the margins burned invariably had nymphs or cast skins of the potato leafhopper (*Empoasca mali* LeB.) on the under sides. Upon investigation, it was found that even the leaves that had been burned entirely brown still had the cast skins of the leafhoppers in numbers, showing conclusively, that the insects had been present on them for some time. Egg scars were also found on all burned leaves at this time. Oftentimes it was possible to find a leaf with a single egg scar, the five cast skins of the different stages of the nymph and the freshly hatched leafhopper, showing that the whole life up to that date had been passed upon the single leaf. The uninjured leaves were also examined, but no egg scars, cast skins, or nymphs were found on them. The adults were just beginning to fly and occasionally a fresh adult, apparently a new arrival, would be found on an uninjured leaf.

DESCRIPTION OF THE INJURY (HOPPERBURN)

The injury varies somewhat with different varieties and different conditions of temperature and moisture, but in general, the first sign is a triangular burned area at the top of the leaf, followed by progressive appearance of burned areas, more or less triangular, along the margin. These areas coalesce as the burning progresses, until the entire margin of the leaf is brown and more or less curled up. The burned margin increases in width, until only a narrow strip along the midrib remains. In the worst cases, this strip and the midrib burn, the leaf dies, and later the plant succumbs, standing burned and dry.

On examining carefully the burned leaves, egg scars will be found in the midribs and leaf stems, as shown in 2, 3, and 4 of figure 7. Often the burned triangle at the tip will be found to extend back nearly to a place where one or more egg scars have so distorted the midrib that it has collapsed beyond that point. The burned areas along the margin will often be found to extend in some distance on the lateral

veinlets and these veinlets will appear collapsed and brown, to a point where there appears to be a series of punctures probably made by the beaks of the nymphs.

The more rapid growing varieties of potatoes suffered less than those of slower growth, apparently due to the larger number of leaves produced. Each leafhopper appeared to be able to destroy a leaf. If there were only as many hoppers as leaves, the plant kept on growing; if on the other hand, there were two hoppers to a leaf, it died.

THE RELATION OF HOPPERBURN TO TIPBURN

Tipburn has been used for years, to designate any hurned condition of the leaves, for which no causal agent could be found, the most common explanation being that it resulted from too rapid transpiration due to abnormal conditions of temperature and moisture, although Dr. L. R. Jones, in first discussing it, suggested that insects might be a factor in its production. It seems probable that a considerable amount of the injury referred to as tipburn, in the past, has been due to the leafhopper. On the other hand, there are, no doubt, other causes of the hurning of potato foliage and it will be one of the problems of the future to differentiate these factors.

At first it was thought that there was a great variation in susceptibility of different varieties, but further study appeared to show that the variation was due to the difference in time that the foliage appeared on the potatoes.

Potatoes that were up at the time that adult leafhoppers were flying in the spring, were injured in about the proportion of their foliage. Potatoes that came up later, even if in adjoining rows, were not injured at all until the adults of the new generation flew to them in July and August.

In every case the first injury appeared on the older leaves, below the top. This was due to the fact that between the time the eggs were laid and the young nymphs had hatched and had time to produce the injury, new leaves would have grown above the injured ones.

CAGE EXPERIMENTS

A cage was put over a medium-sized potato, early in August, and between 200 and 300 leafhoppers added. In three days all of the upper leaves of the plant were rolled up and hurned brown and the growth of the plant stopped. Following this, two cages were placed over potato plants of equal size. Another plant of similar size was selected as a field check. These plants were scarcely two-thirds of the height of the cages and were considerably hurned on the lower half when caged.

In one cage, between 200 and 300 leafhoppers swept from the field

were placed. The leafhoppers on the other plants were carefully removed before the cage was put on. The third plant remained under field conditions and during the next three weeks of hot, dry weather, the burning developed upon the upper part of the plant in considerable amounts, so that the whole field showed a brown cast, where before it had looked green.

At the end of three weeks the cages were removed and the three plants examined, after which their tops were cut off and photographed and then preserved.

The plant on which the hoppers were placed (Pl. 5, fig. 1) had evidently died within a short time, then the leafhoppers died and later, two green shoots came up from the stem near the base. These were green and not burned, while the former top was curled up brown and dead. The check plant had grown but little in height and the burning had progressed clear to the top (Pl. 5, fig. 2). The plant from which the leafhoppers had been removed, had grown rapidly and filled the top of the cage. The leaves were broad, smooth and bright green, with long, acute tips and without a trace of browning (Pl. 5, fig. 3).

IS THE HOPPERBURN SPECIFIC?

The closely related leafhoppers working on rose, apple, grapes and woodbine, produce a whitened appearance on the upper side of the leaves, due to innumerable minute white spots that are apparently the result of feeding punctures. These feeding punctures are practically all made from the under side of the leaves, where the nymphs are found. In no case, however, is there any marginal burning of the leaves, or any browning, until the leaves are so badly injured that they are practically dead.

In the case of the potato leafhopper, the effect is quite different. The burning occurs while the other parts of the leaf are apparently uninjured and the margin of the burned area is always sharp and definite. This leafhopper attacks dahlias and produces the same marginal burning, as well as the same egg scars and distortion of the midribs and veinlets as on potatoes. It is also found attacking water sprouts and fast-growing tips of box elder trees and producing the same type of burning. Water sprouts and fast-growing shoots of nursery stock, and apples are also attacked, the leaves curled and the tips burned. The upper leaves on fast growing raspberry canes are similarly curled and burned.

All the evidence at hand indicates that the hopperburn is produced in every case by this one insect and by this one only. Whether or not it will prove to be a specific disease like the curly-leaf, transmitted by

the beet leafhopper, is yet to be worked out, but in any case, its relation to the potato leafhopper seems to be a specific one.

LIFE-HISTORY OF THE LEAFHOPPER ON POTATOES

The life-history of this species has been studied mainly in connection with its work as a nursery pest and reported under the name of the apple leafhopper.¹ Washburn, Webster and others have reported it as having from four to six generations per year. In practically all of this work the three species of leafhoppers commonly found on apples have apparently been confused.

Parrott was the first to clear this matter up and Lathrop,² working at Geneva, first differentiated the life-histories of the three species. He showed that the rose leafhopper (*Empoa rosea*) wintered as an egg, mainly on roses, produced two generations, the second one on apples; that *Empoasca unicolor* Gill, the true apple leafhopper, spent its whole life on apples, wintering as an egg under the bark and producing a single generation a year; while *Empoasca mali* LeB., hereafter to be called the potato leafhopper, wintered as an adult and produced two broods during the season.

The writer's observations during 1918 indicated that two generations were produced on potatoes. The adults flying in the spring at the time the early potatoes come up, laid their eggs in the stems and midribs of the leaves (fig. 7, 2, 3, 4.) These hatched into nymphs (fig. 7, 1c) that fed on the under sides of the leaves, remaining on the single leaf, as shown by the successive cast skins, unless disturbed or, in case there were several on the leaf, until it died when they would migrate to another. During July and early August the first generation changed to adults and deposited eggs again or flew to the late potatoes to start the second generation there.

PROOF THAT THE LEAFHOPPER CAUSED THE HOPPERBURN

That the burned condition of the potato leaves observed in 1918 was due to the attack of the leafhopper seems to the writer to be well established by the following summary of proof:

First: Cage experiments showed that the leafhoppers could burn and roll the leaves in three days and that plants from which leafhoppers were all removed grew rapidly without sign of hopperburn.

Second: All burned leaves showed on their under surface, either the leafhoppers, their cast skins or egg scars; often all three, while green leaves showed no traces of these. Injury was proportional to the number of leafhoppers.

¹ A more extended discussion together with a complete bibliography will be found in the "Second Biennial Report of the State Entomologist of Wisconsin, 1919."

² JOURNAL OF ECONOMIC ENTOMOLOGY, Vol. II, p. 144, February, 1918.



1. Top of potato plant from cage in which leafhoppers were placed; 2. Top of check plant from field; 3. Top of plant from which all hoppers were removed; 3. (Lower electro.) Potato leaf showing hopperburn and the cast skins of the leafhoppers producing it.

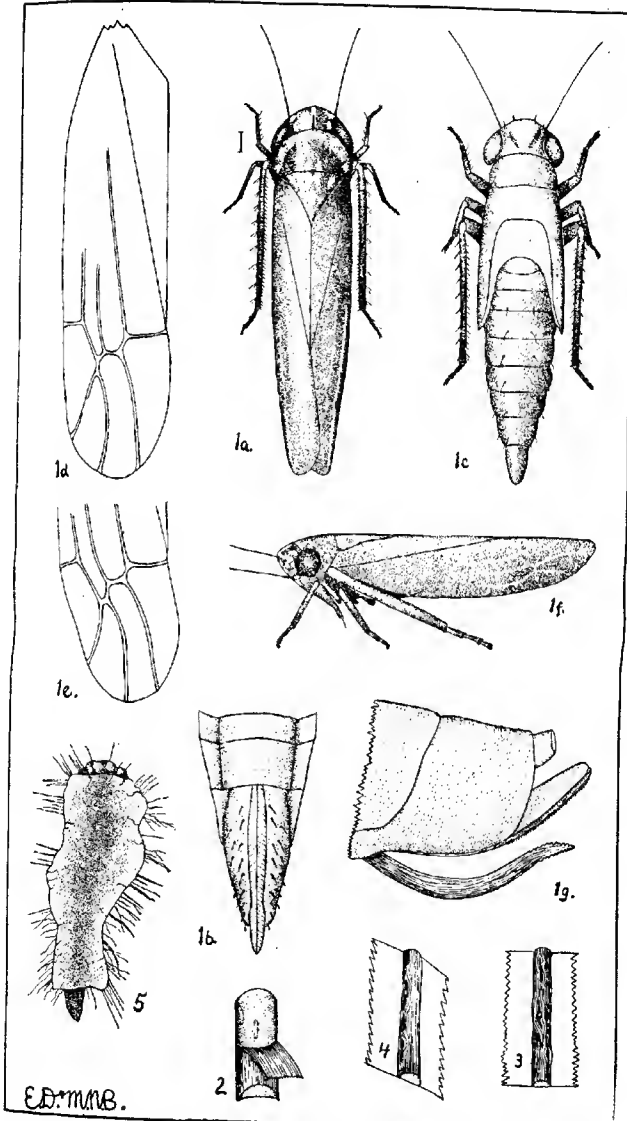


Fig. 7. The Potato Leafhopper; 1, a and f, the leafhopper; c, nymph; d and e, venation of elytron; g, "saw-like" ovipositor with which the eggs are thrust into the stems; 2, eggs in the stem; 3 and 4, egg scars in midrib; 5, nymph killed by fungus.

Third: Burning always appeared on the older leaves below the top of the growing plant, showing that time must elapse before its appearance (time for eggs to hatch).

Fourth: Burning on plants had no relation to position with reference to exposure, to sun or to soil.

Fifth: Burning in fields had no reference to soil condition, slope or exposure.

Sixth: Different varieties were affected according to the time they came up, or according to amount of foliage present when the leafhoppers were laying eggs.

Seventh: Epidemics of leafhoppers and hopperburn (called tipburn) have been observed at the same time, on a number of previous occasions.

Eighth: Other plants attacked by the potato leafhopper show the same distinct types of marginal burning: dahlia, box elder, apple and raspberry.

CONTROL

Spraying with a rather strong kerosene emulsion or with Black Leaf 40, one pint to one hundred gallons of water, to which five pounds of soap have been added, was found effective in killing both nymphs and adults. The sprays must be applied from below, by means of a shepherd's crook made from $\frac{1}{2}$ -inch gas pipe, or applied from above while the plants are drawn over by a suspended board. Two sprayings, a week or ten days apart, applied from opposite directions, were sufficient to control.

VICE-PRESIDENT W. C. O'KANE: Is there any discussion of this paper?

MR. P. J. PARROTT: Is this the same trouble that the plant pathologists call tipburn?

PRESIDENT E. D. BALL: I am with the plant pathologists in saying that there is no question but what some of the things they called tipburn in the past were not this, but a large part of it was this.

MR. P. J. PARROTT: *Mali* winters as an adult?

PRESIDENT E. D. BALL: Yes.

MR. P. J. PARROTT: What are its earlier food plants before it goes over to the potato?

PRESIDENT E. D. BALL: *Mali* goes over to a very large variety of plants.

MR. E. P. FELT: Do I understand that this injury in the opinion of Dr. Ball is largely mechanical?

PRESIDENT E. D. BALL: I doubt it; I am inclined to believe that it is specific, an infection or an injection.

MR. McCAMPBELL: When you advise the farmers to spray, how far apart would the sprays be?

PRESIDENT E. D. BALL: A week or ten days apart.

MR. C. P. GILLETTE: Are the eggs laid wholly on the veins?

PRESIDENT E. D. BALL: On the midribs and the stalks of the leaves. As soon as they have destroyed the leaves they will feed on the stems and destroy them also. But they feed on the leaves apparently up to the time that the leaves die.

MR. H. A. GOSSARD: We had in Ohio the maple injured similarly to tipburn and from the association of this species, we attributed it to that.

PRESIDENT E. D. BALL: This is the leafhopper that injures the growing shoots of nursery stock and young apple trees and burns them; it is the leafhopper that injures the growing tips of raspberry canes; it is not the leafhopper that injures the leaves of apple trees; it is almost never found on a slow-growing apple tree. On box-elder, it is only found on the water shoots or the fast-growing tips.

MR. P. J. PARROTT: In Geneva we have a great deal of trouble on the nursery maples.

MR. J. T. HEADLEE: Can the speaker give us some idea of how much an infestation is necessary to bring about the results on potatoes that he describes?

PRESIDENT E. D. BALL: One leafhopper will destroy a leaf.

PRESIDENT E. D. BALL: The next paper on the program will be by Mr. O'Kane on "Limitations in Insect Suppression."

LIMITATIONS IN INSECT SUPPRESSION

By W. C. O'KANE

At the outset there should be some further definition of the subject of this paper. What I have in mind is a brief discussion of some of the difficulties and problems that arise when the entomologist faces the task of organizing a campaign against a new and serious insect outbreak. Necessarily these difficulties and problems will vary widely with the insect, the part of the country invaded, the host plant and other factors, including the entomologist himself. Therefore that which follows can be only the view of one entomologist, based on an experience necessarily limited and on contact with only relatively few serious insects. That which constitutes a difficulty in New England may turn out differently elsewhere, with another type of citizen to deal with and with another man to do the dealing.

However, no matter where the work or who the worker, there is at

least one limitation that is certain to make itself felt at the beginning of the campaign. That factor is the lack of accurate scientific knowledge of the pest that is causing the outbreak: its life-history, the intricacies of its habits, its preferences as to food plants, and, in turn, the life-history and habits of its insect enemies.

Seldom, I think, shall we find available complete knowledge as to the majority of these vitally important points. If the pest has been introduced from another country we shall certainly have to work out a detailed study of it in this country, not only because recorded information about it in its native habitat will likely be scanty, but because its behavior and its reaction to natural enemies may be a new story here. Clearly, this knowledge must be had before a well-grounded campaign of control can be undertaken.

The agencies that may undertake such a study are available in various quarters,—in our state experiment stations, the state colleges, the state divisions of insect suppression, where such exist, and the Bureau of Entomology of the United States Department of Agriculture. Whatever of these agencies charge themselves with the study, there should be correlation between their work and the efforts of those who have the campaign of control laid on them. Men who are at work on the control side of the problem, if they are scientifically trained, will discover new details that need elucidation and will help to interpret scientific facts as they come to light. Men in investigational work, if in touch with those charged with control, will help preserve an atmosphere of inquiry. Certainly, each will do the better work under the influence of close relationship.

Control measures themselves may, of course, be vested in various individuals or institutions. The entire undertaking may be laid on the Federal Bureau of Entomology. It may devolve solely on the state official in whose jurisdiction the outbreak has begun. We have had examples of both plans.

If the insect is one of great importance, especially if it is an introduced pest that has gained a foothold in only a limited locality but promises to spread to many other states or throughout the country, then it would seem clear that the larger part of a campaign of control should be undertaken by the Federal Bureau of Entomology. A lesser part may be undertaken by such states as are at the moment concerned.

Two arguments may be offered against this theory. A state remote from the outbreak may urge that it should not be called on to help finance control of a pest that is two or three thousand miles away and may never reach its borders at all. It may argue further, that the area which has been so unfortunate as to acquire the pest is not entitled

to bequeath the penalty for that misfortune to other states, any more than it would assume the right to ask other states to help bear its burden of fire losses. As a matter of fact, however, in the case of any really threatening insect that has been introduced into the United States at some point and has actually become established, the pest is a matter of concern for other states, usually for all of them. It has made its start at one particular point, not through the carelessness of the state, as a rule, but by chance; and, in any event, the personal views of individuals as to responsibility will have no effect on the dispersion of the pest into new territory.

The state in which an outbreak has begun may fairly assume an obligation to assist in control measures. In the first place, it has the problem within its midst. The thing is there. It is doing damage. It is a fact on hand. Aside from this, the state may be of real assistance to the federal authorities. For example, a federal quarantine can concern itself only with shipments interstate. Movement of the pest or its host from the infested area to other areas not invaded and within the same state is not subject to control by the federal regulations. Such movement may be controlled by state authority.

It would seem, therefore, that a campaign for control of an insect outbreak may profitably be laid upon both the Federal Bureau and the states immediately concerned; and this applies as well to the necessary study of the insect and its enemies.

The nature of the outbreak itself will determine what degree of control may properly be undertaken. But that degree should be thoughtfully and carefully weighed early in the campaign. It is one thing to retard the spread of a new insect pest; it is another thing to control it; it is still a different thing to suppress it; and it is again otherwise to exterminate it. Very rarely, indeed, may we rightly set about our campaign with the promise of extermination, either implied to ourselves in the arrangement of our campaign, or expressed to the public in any announcements or, especially, in requests for funds. Once in a great while an outbreak arises where actual extermination or eradication is reasonably within hope. For example, I feel that we have such a situation at this moment in the European corn borer, although the possibility of actual extermination is problematical and will cease to be a possibility in another year or two. The work in progress against the gipsy moth is, to my mind, partly a matter of retarding spread, partly a campaign for control through the introduction of parasites, but only remotely a possibility of suppression and the latter only if it should happen that the introduced parasites prove extraordinarily efficient. It is not now a campaign of extermination, though once, years ago, it had that possibility in it.

It is not proper to speak of extermination or to hold it out as an inducement in asking for public funds, unless actual extermination is reasonably in sight. This may be a limitation, for the public likes to think of eradication rather than control, and quite likely will be quite unable to see why actual eradication is not entirely feasible. But if eradication or suppression is promised without sufficient foundation, a mistaken idea is built up which, eventually, will have to be corrected.

It is equally unfortunate to think of eradication in drawing up one's own plans if such an outcome is improbable. Those measures that would be justifiable if eradication is actually to be sought may become a sheer waste of money if a less degree of control is all that can possibly be expected. I must confess to a feeling that sometimes, as entomologists, we have entered on a campaign drawn up on the basis of eradication and involving heavy expenditures, whereas the best promise of ultimate solution lay in accepting the new pest as a permanent resident of our fauna, and determining that it should occupy as low a natural level as possible, in part through systematic introduction of its natural enemies. It must be acknowledged, of course, that it may be possible to get public money for suppression by mechanical means, where such funds would be more difficult or impossible if they are to be spent for travel abroad and for the study of the natural enemies of the pest. Sometime soon I hope that there may be arrangements concluded by which, as I think already proposed by Doctor Howard, we may enjoy the permanent services of experts, whose task it will be to study and to send to us the parasitic enemies of various serious pests that we already have or may acquire.

Granted, however, that direct means of suppression such as spraying, must be undertaken on a large scale, in the course of a campaign to control an insect outbreak, will it be desirable to get this work done by placing the burden of responsibility on the private property owner or should it be undertaken by men employed by the state or federal authorities?

If the insect is really a very serious one and if the aim of the campaign is to exterminate it or to stop spread, then I feel that dependence on the owner of private property will be wholly inadequate. There are various reasons for this. Eradication must be absolutely thorough. It does not mean to do a job that is 60 per cent complete or 80 per cent complete. It means to approach closely 100 per cent. Even suppression in the stricter sense means thorough work, properly performed at the proper time, and systematically carried through wherever the pest exists.

There are many private property owners who could do their share, having the money, the time and the intelligence. But even some of

these will fail because they will delegate the work to others who will prove incompetent or because they themselves will, on account of their multiplicity of interests, fail to move at the right time.

In contrast to these favored individuals there are many others, probably a majority, who lack the means, the time or the understanding to carry out real control measures. Their intentions may be excellent but their performance will not average high.

Against this idea it may be argued that statutes can provide for compulsory suppression, requiring a property owner to take certain measures, and can make a further provision that, if he fails, the work shall be done by a public official and the cost charged against the property as a part of his taxes. This will not necessarily succeed. No statute can make a man do thorough work if he is inclined to be careless. No law can teach every individual that adherence to some seemingly unimportant detail may be the key to success in control.

Furthermore, there is a definite limitation as to the amount of cost that the statutes may charge against a property. This is true whether the law requires the owner to do certain work or whether it provides that the work shall be done by a public official and the expense charged in the taxes. In either event it is necessary to limit the charge to some percentage of the assessed valuation of the property concerned. The maximum percentage that appears allowable is one half of 1 per cent. To assess that much means, usually, to increase ordinary taxes by 25 per cent. But one half of 1 per cent for a farm assessed at \$5,000 is only \$25, and the latter sum may be only a tenth of the actual cost of the work that should be done on the property in question.

If it be argued, in turn, that the state or federal government may properly assume the remainder, the reply is that the government had better assume the whole thing and do the job, thus placing it in the hands of trained men who have that one thing on their mind and whose duty it is to perform the task completely and at the proper time.

If, however, the campaign of suppression at hand is one of more liberal interpretation, in which the aim is to mitigate the damage done, to retard spread, to establish natural enemies, in other words, to accept the pest as a new member of the fauna, but to bring it to the lowest possible level of normal abundance, then there is good reason for asking the property owner to assume from the start an individual share in the burden of control. Indeed, to do anything else is to convey to the mind of the people an impression that the state or federal government is going to assume full responsibility for the pest in question and that the private property owner need not concern himself about it, either now or in the future.

To get the individual to conduct proper control measures means to

carry through a campaign of education and stimulation. In fact, in planning any comprehensive program of insect control there is reason for adopting a definite schedule of educating the people, in order that they may give to the problem intelligent and competent support, financial and otherwise.

At the best, the results of such a program of education will fall far short of the mark that one would like to set. When it would seem that certainly every citizen in the state must have come to understand the principal facts about a disastrous insect outbreak, the entomologist certainly will discover that six out of ten of those with whom he talks have practically no real conception of the problem and probably are sadly mixed in such information as they have absorbed.

It follows that every available means must be used if a considerable percentage of the public is to be reached and to be taught the essential facts that eventually the property owner must know. The newspapers will reach some, although their message will actually get into the minds of a much smaller number than one at first anticipates. Circulars and bulletins serve their purpose, but here, again, I doubt if more than one out of five mailed out is read or absorbed by the recipient. Posters can be made to help, provided they are very brief, so that their import can be seized at a glance. Any printed matter should invariably be simple, concise, void of technical terms and well illustrated. One page is better than two if one can possibly suffice. Two pages are better than four.

The spoken word will get a message home where no circular or bulletins can find entry. People will listen to that which you say though they may lay aside that which you have had printed for them. The best combination is the spoken word, reinforced by the printed circular distributed at the same time, and exemplified by the insect itself or its work actually exhibited.

At the best, there is apt to be difficulty enough in getting adequate funds for a real campaign of eradication or of strict suppression of a threatening insect. Certainly sufficient funds constitute an absolutely vital factor if the campaign is one of this nature. If it requires \$100,000 to suppress a new insect at the beginning of its career, to spend half of that sum may be practically to throw the money away. The campaign must go the whole way. To stop short of the whole task is to build a bridge that lacks one or two spans. It may be an excellent structure to look at but it will be no good as a bridge.

And, finally, there is the limitation of human capabilities among those who are planning and directing the campaign. I believe that seldom, indeed, shall we find, in the same man, the qualities that will make him successful in conducting the scientific investigation of an

insect and will, at the same time, make him competent as the administrative head directing the staff who carry out the measures of suppression. On the other hand, as he is more typically an administrator, so his talent will less readily find expression in the details of investigation. There is need for specialists in both fields.

PRESIDENT E. D. BALL: The paper is now before us for discussion.

MR. T. J. HEADLEE: We have heard a great deal during this meeting about the necessity of the business administrator in carrying out work for the suppression of injurious insects. While I agree heartily with the idea that a business-like administration of such a project is a necessity, I want to point out that a purely business administrator is just the man not to have in charge of such a project. He believes from his experience that the methods of procedure should be easily and definitely laid down and he will have no patience with the uncertainty which the nature of the problem creates in the mind of the entomologist. Pure business administrators for large projects of this kind, for directors of experiment stations and presidents of colleges are likely to prove a failure, because the very standardization which such a man will tend to introduce will destroy the initiative and render sterile the mind of the specialist without freest activity with which success cannot be had.

MR. McCAMPBELL: In the matter of educating the public, I wonder if you realize how far your appropriations would go if you spent them with some of the weekly and farm papers in the form of pure editorial matter. My observations in Monmouth County are that the farmers there read the two country papers religiously; they read everything, and if the experiment station in New Brunswick wishes to reach those farmers, let them get up a nice readable story which the farmers can understand, and bring it right home to them, you will reach every farmer in the country. A little bit of time spent with those editors will get you two to five times as much through the editorials. I think this would be a wonderful way to get this information to them, and I am sure it will do lots of good.

MR. H. A. GOSSARD: I wish to call attention to the fact that if we are going to call upon the infested districts to bear the full burden of suppression, that certain parts of our country will be loaded with nearly all of that expense. The great ports of entry for insect pests are in the New England and Middle States, and nearly all of our serious pests have gained entrance into the country from these points. We cannot reasonably expect that these states will pay for everything or feel that it is their duty to suppress all pests that may have entered

the country through their ports of entry. If we are going to get adequate means, the whole country must get under the burden and help, otherwise these few states will get weary of the load and leave it to those states which are most interested, but which won't realize what they must do to stay the invasion, until it is too late.

MR. C. P. GILLETTE: We speak quite often about insect extermination. I would like to have the members of this body give us a list of the insect pests we have exterminated in this country.

PRESIDENT E. D. BALL: We have exterminated the gipsy moth in half a dozen places; wherever they have tried, since they really took hold of it.

MR. J. G. SANDERS: The pink bollworm is well under way.

PRESIDENT E. D. BALL: The potato bug has been exterminated in some countries we know.

MR. W. D. PIERCE: The cattle tick has been exterminated in whole states.

PRESIDENT E. D. BALL: The scabies is practically eradicated from the western range.

The next paper is on "Control of the Chrysanthemum Gall Midge with Nicotine Sulphate—with Notes on Life-Cycle," by T. L. Guyton.

NICOTINE SULFATE SOLUTION AS A CONTROL FOR THE CHRYSANTHEMUM GALL MIDGE, *DIARTHROMYIA* *HYPOGAEA* H. LW.

By T. L. GUYTON, Harrisburg, Pa.

A brief study of *Diarthromyia hypogaea* was made at the Ohio Agricultural Experiment Station under the direction of Prof. H. A. Gossard. The writer is indebted to Professor Gossard and Mr. J. S. Houser for helpful suggestions in applying control measures.

Diarthromyia hypogaea, a European pest for many years, was first recorded in this country in 1915 by Dr. E. P. Felt from specimens taken from greenhouses in Michigan. Professor Essig of California reported its presence in that state in 1915 and 1916. The first known outbreak in Ohio greenhouses was in February, 1918.

LIFE-HISTORY AS NOTED IN GREENHOUSE

This study extended from the last of February to first of May, and one complete brood was observed. The length of the life-cycle is from forty to fifty days in a greenhouse where the temperature was about 70° F. The eggs are placed promiscuously about the young, growing part of the host plant, and the number deposited by each female is from 80 to 150.

CONTROL WORK

Nicotine sulphate solutions were used first of all with a hope of penetration sufficient to kill the larvæ within the galls. Upon examination a few hours after application a number of dead individuals were found at the point of emergence from the gall. Cages were at once prepared and tests made with the following results:

TABLE I. RESULTS OF NICOTINE SULPHATE SPRAY ON EMERGING CHRYSANTHEMUM MIDGE.

Spraying Done 2/23 Date of Observation	"Pot 1" Sprayed with 1-500 Nicotine Sulphate and Soap		"Pot 2" No Treatment		"Pot 3" No Treatment		"Pot 4" Sprayed with 1-250 Nicotine Sulphate and Soap	
	Emergences		Emergences		Emergences		Emergences	
	Dead	Living	Dead	Living	Dead	Living	Dead	Living
2/25	0	0	0	2	0	2	3	1
2/26	0	0	0	0	0	3	1	0
2/27	0	0	0	0	0	0	2	0
2/28	2	0	0	9	0	7	6	0
3/1	4	0	0	15	0	0	2	0
3/2	3	0	0	20	0	4	5	1
3/4	0	0	0	38	4	6	1	1
3/5	0	0	0	0	0	0	0	0
3/6	3	0	0	10	0	9	0	2
3/7	3	0	0	5	0	3	0	1
3/8	0	0	0	1	0	1	0	0
3/9	0	0	0	2	0	0	0	0
3/11	0	0	0	0	0	0	0	0
3/12	0	0	0	1	0	0	0	0
3/13	0	0	0	0	0	0	0	0
3/14	0	0	0	3	0	0	0	0
3/15	0	0	0	2	0	0	0	0
Total	15	0	0	108	4	35	20	6

The cages were prepared by placing a heavily gall-infested plant in a five-inch flower pot, and covering the surface soil with about one-half inch of pure quartz sand. The plant was caged by placing a large lamp chimney over it. The top end of the lamp chimney was closed with one thickness of cheese cloth.

GREENHOUSE TESTS OF NICOTINE SULPHATE

A bench about twenty feet long and three feet wide, containing about 250 plants of a number of varieties of chrysanthemums, all infested with galls of the midge, was used as a trial. The plants on this bench were the only chrysanthemums in this particular room of the greenhouse, and they were cared for as in the usual practice of the caretakers. The plants were sprayed with a one to five hundred solution of nicotine sulphate and water, to which one ounce of caustic soda fish oil soap had been added to each gallon of solution. The spray was applied six times in all, with five-day intervals between each application. Observa-

tions made at the end of the treatment are: The plants were in a good growing condition, showing no ill effects from the spray application. No eggs or adult forms of the midge were to be found. Six plants had midge galls, the contents of which were blackened and soft as seen under a binocular microscope. Many emerged adults, galls and eggs of the midge were evident among check plants in another room of the greenhouse.

Examinations of the galls during the time of treatment showed that in many cases the larvæ and pupæ are not killed by the spray, but that the emerging adult is killed, probably by the moisture on its body coming in contact with the dry spray material on the outside of the gall. Thus to be effective in killing the midge, the spray mixture should be present throughout the period of emergence. Evidence was obtained which showed that at least a large per cent of the eggs are destroyed by this spray.

CONCLUSIONS

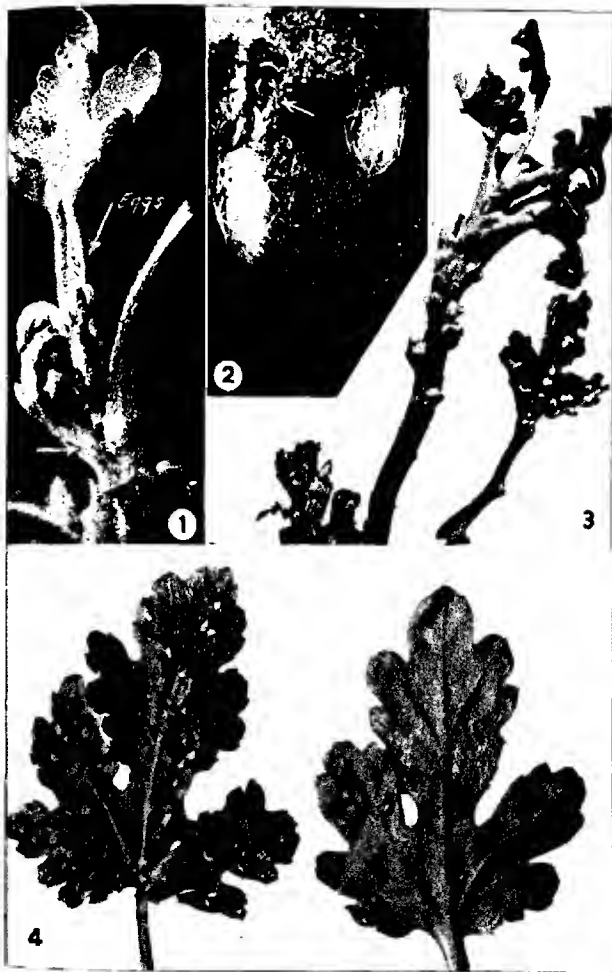
It is the belief of the writer that the chrysanthemum midge can be successfully controlled at the time of emergence of the adult by spraying with a solution made of one volume of nicotine sulphate containing 40 per cent nicotine to five hundred volumes of water, to which fish oil soap has been added at the rate of one ounce to each gallon of solution. Since all the adults do not emerge at the same time the treatment must be repeated every four or five days, as long as any living forms of the midge remain in the galls. The plants must be completely covered with the spray solution.

MR. J. G. SANDERS: This insect is comparatively new to greenhouse men, in fact it has occurred at widely separated points in the country. Those of you who have not seen its work will hardly appreciate the tremendous damage done to growing chrysanthemum plants due to the stunting of the buds.

MR. E. R. SASSCER: For the past year or more we have been conducting life-history and remedial work in Washington with this insect. We found by using nicotine sulphate, and continuing to spray every second or third day for a period of about 35 to 40 days, the midge could be controlled. We have also tried burning nicotine papers, but have found that if you burn often enough to be effective against the midge, it will injure the plants. We have practically eliminated this insect in a commercial house by spraying with nicotine sulphate.

MR. E. P. FELT: I would like to ask Mr. Sasscer if he has been able to try it against the box leaf midge.

MR. E. R. SASSCER: No, I have not.



Diarthronomyia hypogaea: 1, Eggs on young portion of plant, enlarged; 2, Individual dead at point of emergence from the gall, enlarged; 3 and 4, Stems and leaves of host plant showing the galls, about natural size.

MR. E. N. CORY: I might say that we worked on the box leaf midge some years ago, and in a small way. We were unable to get any results with nicotine sulphate.

MR. E. P. FELT: Was the spraying at the time when you would catch the pupæ as they were pushing out of the galls? They have just about the same habit.

MR. E. N. CORY: It was an attempt to get penetration and to kill the larvæ.

PRESIDENT E. D. BALL: We will call on Mr. Sasscer for a résumé of Mr. Woglum's paper on "Recent Developments in Fumigation with Liquid Hydrocyanic-acid."

MR. E. R. SASSCER: I am very sorry that you have not time to hear this paper of Mr. Woglum, because it shows the latest developments of hydrocyanic-acid gas fumigation in California. You are all familiar with the old pot method where sodium cyanid is placed in the dilute sulphuric acid.

[See p. 117-123 of February issue for text of this paper. Ed.]

MR. W. E. BRITTON: I would like to ask Mr. Sasscer if he has tried this out in greenhouse fumigation.

MR. E. R. SASSCER: No, I have not tried it out. I hope to give it a test as soon as a suitable shipping container is found.

MR. P. J. PARROTT: What is the effect on the valves or the metal parts of your machine? We find that the valves give way after the third year of use.

MR. E. R. SASSCER: I am unable to answer this question since all of this work has been under Mr. Woglum's supervision.

MR. T. J. HEADLEE: I would like to ask the speaker if he has used the ordinary soda bottle, with the CO₂ gas?

MR. E. R. SASSCER: It is understood that I have not used liquid hydrocyanic-acid and that all of the work referred to was done in California under Mr. Woglum's supervision. I am told that an apparatus working on practically the same principle as a soda bottle can be satisfactorily used.

MR. W. H. GOODWIN: Have they in any case used the oxygen or hydrogen steel drums?

MR. E. R. SASSCER: I do not know. All of this work has been done in California.

MR. W. H. GOODWIN: I know that in our cyanide work where we use the liquid cyanide, all brass connections and valves will soon be

eaten away, and I know that the hydrocyanic liquid gas must have a much more serious effect than the cyanide.

MR. E. R. SASSCER: Hydrocyanic acid is said not to injure cloth, and therefore tent burning is reduced to a minimum.

Adjournment.

[Papers read by title.]

THE WORK IN THE UNITED STATES AGAINST THE PINK BOLLWORM

By W. D. HUNTER, *Bureau of Entomology and Federal Horticultural Board,
U. S. Department of Agriculture*

HISTORICAL

The protection of the United States against the pink bollworm (*Pectinophora gossypiella* Saunders) was first seriously considered by the Department of Agriculture in April, 1913, when the writer brought to the attention of the Federal Horticultural Board the strong possibility that the pest might be introduced at any time in cotton seed from Egypt or other infested countries. Shortly thereafter a quarantine was promulgated to take effect on July 1, 1913. This quarantine prohibited the importation into the United States of cotton seed of all species and varieties and cotton seed hulls from any foreign locality, except the Imperial Valley in the State of Lower California in Mexico, where the cultivation of cotton is continuous with the growth of the crop in California. In August of the same year an amendment was issued which provided for the entry under regulations, for milling only, of cotton seed from certain additional northern states in Mexico.

It was soon found that the quarantine against cotton seed and hulls was not sufficient to protect this country for the reason that considerable quantities of seeds, in some cases as many as 600 per bale, were arriving in lint. Consequently means were taken to regulate the importation of lint and to require its fumigation in vacuum apparatus devised after a long series of experiments by Messrs. E. R. Sasscer and L. A. Hawkins. In the meantime the destruction of the seeds found in opening and cleaning foreign cotton was provided for in all mills utilizing such cotton, regardless of their location in the United States.

It was also necessary on account of the occurrence of the pink bollworm in Hawaii to place that territory on the same basis as foreign countries in regard to shipments of seed, hulls and lint.

During all this time, of course, it was not known that the pink bollworm existed in Mexico. Suddenly, however, on November 1, 1916, specimens of the insect were received through Mexico City from a

plantation in the Laguna district in the northern portion of the country. It developed that during 1916 about 400 carloads of Mexican seed had been shipped to Texas mills. Such shipments were unprecedented and due entirely to the disturbances in Mexico which had prevented the operations of the large mills in the Laguna, which normally crushed all of the seed produced there.

The Mexican seed shipped to Texas was received at eleven oil mills located in various parts of the state, some of them in actual contact with continuous cultures of cotton.

CONTROL MEASURES IN TEXAS

Immediately steps were taken to safeguard the Mexican seed in the Texas mills by early and special crushing and in other ways. The mill properties themselves were thoroughly cleaned under the supervision of the Federal Horticultural Board during the winter of 1916-17. This work was followed in 1917 by very thorough inspections by a number of agents of the cotton growers in the vicinities of the mills which had received the Mexican seed. The results of this work were all negative until September 10, 1917, when Inspector Ivan Schiller found a specimen of the pink bollworm in a field at Hearne adjoining a mill which had received 67 carloads of Laguna seed. On October 5 a single specimen was found near the oil mill at Beaumont, Texas, which received 114 carloads from Mexico, and on October 25 specimens were taken near Anahuac, in Chambers County.

The first two of these infestations, namely at Hearne and Beaumont, were very evidently due to the Mexican seed which had been received. The infestation at Anahuac, however, cannot be connected with the seed shipped from Mexico. All investigations which have been conducted point to the very strong probability, if not certainty, that the Anahuac infestation was due to the washing ashore and breaking of a number of bales of Mexican cotton which were carried inland by a storm which passed over Galveston in August, 1915.

PLAN OF OPERATIONS

In the three places where infestation was found the same general plan was followed by the board. The first step was to delimit the infestation, the second to destroy, as far as possible, any infestation existing in the fields, and the third to safeguard the cotton and cotton products originating in the infested territory.

The infestation at Hearne was found to be very limited. This was determined by inspections made by about fifty entomologists detailed from the Bureau of Entomology and by a number of regular employees of the board. Likewise the infestation at Beaumont was found to be

limited to the fields planted in seed from the mill. This seed was used for this purpose in violation of the agreement on the part of the mill that it should be crushed immediately.

The infestation at Anahuac was soon found to be very extensive. It extended 25 miles south of that place to Smiths Point, but this was not the end, since the work of the inspectors revealed the presence of the pest on the opposite side of the Bay in Galveston County. As this work was continued during the winter of 1917-18 specimens of the pest were found in 161 fields, extending from the Neches River practically to the Brazos River, a distance of 125 miles, and inland a distance of approximately 75 miles. The territory thus found to be infested covers 5,400 square miles, and includes all or portions of seven counties. It is considerably larger than the entire State of Connecticut and about three-fourths as large as the State of New Jersey.

While the work of delimiting the infestation in southeastern Texas was under way, the work of cleaning the fields was begun. The procedure followed was to cut down the cotton plants standing in the fields, place them in piles, then collecting by hand all of the bolls and particles of bolls on the ground, placing them on the piles of the stalks and burning the whole by the use of kerosene.

The country in southeastern Texas is sparsely settled, and the farms separated by great distances. The local labor available was entirely insufficient for cleaning the fields thoroughly and with dispatch. Consequently gangs of laborers were organized who were housed and provisioned and distributed by motor trucks at the expense of the department. At one time the department had over 1,000 laborers engaged in the work, as well as twenty motor vehicles. The cleaning of the fields cost the department \$87,439.88 on 8,794 acres, an average of \$9.94 per acre. The cost in some cases was as high as \$30 per acre, where the fields were especially far removed from the camps, and where they were filled with stumps or grass, or otherwise difficult to clean properly.

The field work was greatly facilitated through the taking over of a number of trained men who were in the employ of the State of Texas and the Bureau of Plant Industry in the work of eradicating citrus canker.

The safeguarding of the cotton and the cotton products originating in the infested territory in 1917 (and in 1916, as that year's crop had to be considered nearly as dangerous as that of 1917) was accomplished by the exportation of the lint through the coöperation of the dealers and the crushing of the seed under special supervision in approved establishments in the City of Houston.

QUARANTINE AND NON-COTTON ZONES

In 1917 a special session of the Legislature of Texas, at the suggestion of the Department of Agriculture, had provided a pink bollworm act. This act became effective on December 28, 1917. During the period between the finding of infestation and the date the law went into effect, through the coöperation of the railroads and shippers and the vast majority of the farmers, practically effective voluntary quarantine measures were enforced. The special statute gave authority for the quarantining of districts found infested by the pink bollworm and for establishing non-cotton zones, if necessary. It was most fortunate for the cotton industry of the country that this statute had been provided.

The first steps taken under the law were to establish quarantine and non-cotton zones at Hearne and in southeastern Texas. In both cases a considerable area beyond the last points found infested was included as a safety belt. In southeastern Texas the width of this safety belt varied from 6 to 10 miles, depending on local conditions.

The difficulties in the way of establishing a non-cotton zone in southeastern Texas were considerable. The area included 38,000 acres of cotton in 1917. The territory had suffered several agricultural catastrophes, including the failure of the citrus industry. Although the region is normally too humid for cotton, there had been two dry years which had enabled the farmers to produce unusual crops, and this fact gave cotton in general estimation an importance which it cannot be said to deserve. With war prices for the staple, the general state of the public mind at the suggestion of a non-cotton zone can well be imagined.

OBSTACLES ENCOUNTERED

Although realizing the difficulties very keenly, the Commissioner of Agriculture, Fred W. Davis, and the governor of the state took the very commendable stand that the case required the establishment of a non-cotton zone, and the steps necessary to that end under the law were taken.

As was expected, a few farmers, through lack of information and some for other reasons, planted cotton on their places. A test case of the law was soon provided. A planter in Liberty County had put in 125 acres of cotton. He was arrested under the provision of the law which prohibited the planting of cotton in non-cotton zones established by proclamation of the governor. It was found on the trial that the statute was defective in that, while prohibiting the planting of cotton under certain conditions, it did not specify a penalty. The penal code in Texas requires the indication of specific penalties in such

cases, and the state lost the case. The trial judge made it very clear in rendering his opinion that the general validity of the act had not been questioned. After the trial appeals were made by representatives of the board as well as by the state officials to farmers everywhere to comply with what was the clear intent of the law. These appeals were effective in many cases, but naturally a considerable acreage was planted on the supposition that the decision in the test case meant that the entire law was invalid. Altogether about 3,500 acres of cotton were planted in the non-cotton zone. Through direct appeals and appeals through bankers and merchants, much of this cotton was plowed out. In one considerable district every field planted was voluntarily destroyed. There remained, however, 1,741 acres which were cultivated and continued to grow.

THE LAW FOUND TO BE CONSTITUTIONAL

The state and Federal governments cooperating undertook to establish in court that the growing of this cotton in violation of the governor's proclamation constituted the maintaining of a public menace. A test case was made against the president of an organization formed to fight the law, who had planted 30 acres of cotton. The trial lasted over two weeks. The judge went very thoroughly into all features of the law. The attack was on the score that the law was unreasonably drastic, that sufficient protection could be obtained by allowing the growing of cotton under regulations and the safeguarding of the products. However, the court decided that the law was reasonable and constitutional, and the defendant was ordered to destroy the crop forthwith. Upon his failure to do so in ten days, he was committed to jail. In a few days he was released on a writ of habeas corpus issued by a higher court, and a hearing was set for October 10.

AN AGREEMENT WITH PLANTERS

During all of these legal complications, the cotton planted in violation of law continued to grow, and there was every prospect that it would be entirely harvested before the hearing on the habeas corpus case could be had. The agencies cooperating were therefore confronted with the facts that about 600 bales of cotton, of the value of approximately half a million dollars, had been produced; that if the state did not obtain custody of this crop, a considerable part would be smuggled out of the territory by means of the very numerous water courses in the region, and—anticipating a point which will be dealt with fully later—that no infestation by the pink bollworm had developed. It therefore became clearly advisable to make some provision which would give the state practical custody of the crop. After numerous plans were

considered, it was finally decided to make a compromise with the planters. This provided that the state would make no further prosecutions provided the planters would sign a formal agreement including the following points: (1) To turn over the seed and lint produced to the state, so that the former could be crushed under supervision and the latter exported; (2) to clean the fields thoroughly, depositing money at the rate of \$20 per bale for each bale produced to guarantee that this work would be done properly; and (3) to agree not to plant cotton again during the term of any prohibition against it, and to submit voluntarily to an injunction from which there would be no appeal. After some little effort, all of the 134 persons who had planted cotton in violation of law signed the agreement, and the crop is now being disposed of under safeguards. It is considered that this plan is altogether the best one which could have been followed in view of the difficulties the state had encountered, and the actual fact that a large and valuable property had developed. The work of executing the agreement is being carried on by the state and Federal agencies coöperating, and has met with few important obstacles.

VOLUNTEER COTTON IN NON-COTTON ZONE

During the season the Federal Horticultural Board has assumed a definite share of the work of maintaining a non-cotton zone in that it undertook to destroy all of the volunteer cotton growing therein. Such cotton appeared in considerable quantities in the majority of the fields throughout the non-cotton zone. The work of finding, collecting, inspecting and destroying this volunteer cotton was begun in June and continued for a period of six weeks. It was found, however, that some volunteer plants appeared during the summer, and it became necessary in September again to go over the entire territory. The district was divided into sections placed in charge of different men who employed local labor and collected the volunteer cotton plants. In all cases these plants were taken to central points where all of the fruit was given most careful examination by inspectors trained to find the pink bollworm or evidences of its work. In this way over 3,000,000 volunteer cotton plants and the fruit on them have been examined. In many cases these plants came from fields where infestation was determined to exist last year. The results up to the present time have been altogether negative. Not a trace of the insect has been detected.

In a single case a few plants were allowed to grow in a field which was infested in 1917. This was near Smiths Point in Chambers County, where much the heaviest infestation found in Texas had been located last year. It was easy to find bolls with ten or twelve larvæ within, and at least 75 per cent of the November bolls had more or less infesta-

tion. The field was planted to sweet potatoes in 1918. Fifty-one volunteer plants were allowed to grow and develop bolls. These bolls have been examined on five occasions very minutely by a group of the most competent inspectors available, but no infestation has been found.

GENERAL SCOUTING IN 1918

An average of forty men were employed on the work of scouting during the season of 1918. This work included the general vicinities of the eleven mills which received Mexican seed in 1916, and a number of places to which hulls or other more or less dangerous material were shipped in 1916 prior to the time when the department took charge and safeguarded the products. In a few cases hulls which may have been infested were shipped to other states, such as Arkansas, Louisiana and Mississippi. At the places where these hulls were received, inspections have been made similar to those in Texas. Likewise thorough inspections have been made in some of the Eastern states which received Mexican cotton in 1915. In all cases the inspections have yielded absolutely negative results.

It seems almost inconceivable that the pink bollworm has been stamped out in the large territory which it was found to occupy in southeastern Texas, but the thorough inspections which have been made, including the examination of all the volunteer cotton plants, indicate that if it has not been exterminated, it has been reduced very close to the vanishing point.

The reasons for this apparent success, which it is hoped will be found real, are somewhat obscure. It is evident, however, that certain factors operated in a very important way towards the results which have been obtained. In the first place the work of cleaning the fields, that is, burning all portions of the cotton plants which might carry infestation, must have destroyed millions of the insects. That this was the case is evident from the fact that in many localities during the process of piling the plants, a person could remove bolls from the plants and in a few minutes find specimens of the pink bollworm. The winter which followed this work of cleaning the fields was unusually severe, bringing temperatures almost unprecedented in southeastern Texas. This condition must have caused the death of many of the larvæ which, hidden in bolls covered with earth in footprints and elsewhere, were missed by the laborers. At the same time it must not be assumed that the low temperatures were responsible for killing all of the insects which remained after the cleaning of the fields, since specimens in perfect condition were found on a number of occasions after the lowest temperatures had occurred. The last factor which

must have been influential in reducing the pest was the establishment of a non-cotton zone. It is true that there were 1,700 acres planted in this zone, but that was a small amount in comparison with 50,000 acres which would otherwise have been planted. Moreover it happened that practically all of the fields planted in cotton in violation of law were on land which was not in cotton during the preceding year, and there was no cotton whatever planted in the districts where the heaviest infestations were found. There the non-cotton zone was absolute. Some specimens which may have escaped both the cleaning of the fields and the vicissitudes of the winter may have appeared. If this was the case, the chances are that they were in the localities where there was no cotton, and their chances of propagating were eliminated or practically eliminated.

Observations made in India, Egypt and Brazil show that the pink bollworm, under certain conditions, may propagate in plants other than cotton. These include okra, Indian hemp, hollyhock and related plants. In so far as okra and hollyhock are concerned, these observations have been confirmed by investigations made recently in Mexico by Mr. August Busck and his associates. In Texas, in addition to okra which is very commonly grown, there are four species of *Hibiscus* even more closely related to cotton than okra, which might support the pink bollworm. These wild plants grow in large colonies, and are of very general occurrence. The inspections made during the season in the non-cotton zone have included the minute examination of many thousands of these plants. In cases all of the seed pods on large groups of these plants growing in the vicinity of pink bollworm infestations of the year before were examined with negative results.

THE OUTLOOK

Despite the encouraging outlook, it is not assumed that the pink bollworm has been eradicated in the United States. The situation is such, however, that it has been decided to allow the planting of cotton in the non-cotton zone in the southeastern part of the state during the coming season under regulations as to the seed planted, as to the handling of the crop, the cleaning of the fields and the destruction of growing crops found infested without compensation, as will enable the agencies coöperating to take early and radical steps, if necessary. The feasibility of safeguarding the cotton products produced in the territory has been proven by what was done with reference to the crop of 1917 and the outlaw crop of 1918. Certainly if the infestation has not been eliminated altogether it is much less than it was in previous years, and the risk, if there is any, to be carried in connection with the

planting of cotton in 1919 is much less than has been carried by the country for some time.

It is planned to maintain a large corps of inspectors to examine the cotton grown under supervision next season. These men will also inspect the fields growing in the vicinities of the mills which received the original Mexican seed. It is entirely probable that any situation which may arise next year can be handled speedily, and such steps can be much more satisfactorily taken than in the past on account of certain modifications of the pink bollworm law which will undoubtedly be provided by the next session of the Texas Legislature.

PROTECTION AGAINST REINFESTATION FROM MEXICO

As indicated earlier in this paper, since November 4, 1916, the importation of cotton, cotton seed and cotton seed hulls from Mexico has been prohibited. Later regulations have covered the entry from Mexico of cotton seed cake, meal and oil. The object of this last provision is to discourage the erection of oil mills along the Rio Grande, which would naturally cause the flow of large quantities of seed from the infested portions of Mexico to our border. It has already resulted in the dismantling and moving to the interior of a mill which was erected opposite Eagle Pass.

Since cotton seed may be carried accidentally in empty freight cars or attached to freight of many classes, regulations now in effect include the inspection and disinfection of baggage, the cleaning or disinfection of freight, express or other shipments except those which could not possibly carry infestation, restrictions on the entry of railroad cars, regulations for the transfer of freight, express and other shipments, certification of all cars or other carriers of merchandise as a condition of entry into the United States (excepting merchandise or other materials of strictly local origin), and the cleaning of domestic cars as a condition of receiving freight originating in Mexico for movement into the interior of the United States. The present regulations provide for the fumigation of the interior of cars with hydrocyanic gas and the spraying of the exteriors with kerosene emulsion. However, the department is now erecting houses into which cars will be run and fumigated. These houses will be located at all of the border ports, and will range in size from a capacity of one to fifteen cars, depending on the amount of the local international traffic. The houses themselves have been erected. It is believed that the machinery such as generators and fans will be installed within the next few weeks.

A FRESH INFESTATION

At about the time this was written, a new infestation by the pink bollworm was discovered in Texas. This is in the extreme western part of the state along the Rio Grande, where the insect has been found in widely scattered fields along a front of 150 miles. Everything indicates at this time that the infestation is due to the smuggling of seed across the river from Mexico. The region is isolated from any other territory in the United States in which cotton is planted by hundreds of miles of mountains and deserts. To control the situation there as it now appears is a matter of the utmost simplicity compared to the gratifying and possibly absolute control which has been obtained in other parts of the state. The finding of the new infestation at present, therefore, does not seem in the slightest degree to detract from the present generally hopeful outlook.

INVESTIGATIONS IN MEXICO

This paper would not be complete without at least a reference to the work of the Department of Agriculture in Mexico. This is conducted under the direction of Mr. August Busck. It includes studies of the bionomics of the species to serve as a basis for control measures which may be put into operation in case, by any chance, the pest ever becomes established in the United States. It also includes an effort towards the total elimination of the pink bollworm in Mexico. This project is by no means as visionary as might be supposed, and definite progress has already been made. This subject, however, must be dealt with more fully in a paper prepared by Mr. Busck, which in the nature of the case cannot be written until there has been time for further developments in Mexico.

PARASITE INTRODUCTION AS A MEANS OF SAVING SUGAR

By T. E. HOLLOWAY, *Entomological Assistant, Bureau of Entomology, Department of Agriculture*

This paper is a report of progress on work in parasite introduction, but it may also serve to point out the benefits which may come from the active interest of the agricultural public in any bit of scientific endeavor which appeals to it.

The control of the sugar cane moth borer, *Diatraea saccharalis*, has been a subject of investigation in Louisiana for many years. As time passed and experimental results accumulated, it became more and more apparent that only by the introduction of foreign parasites could

control be effected. In Cuba the moth borer was known to be much less injurious than in Louisiana, and in 1914 Mr. George N. Wolcott reported a tachinid parasitic on the larva. In 1915 the Bureau of Entomology arranged to investigate this parasite, with the intention of introducing it into Louisiana. Mr. U. C. Loftin was sent to Cuba, where he traveled about over the island, collecting parasites and sending them to the writer at New Orleans. Though they attacked the moth borer in Louisiana, they subsequently died out.

Experience has been gained, however, in methods both of collecting and breeding, and it was intended to continue the work the following year. But lack of funds and the department regulation prohibiting foreign travel during the war prevented parasite introduction during the next two years. The same conditions prevailed during 1918, but some of the sugar planters in Louisiana had become interested, and at the meeting of their association in New Orleans in June one member proposed that those so inclined subscribe one hundred dollars each to defray the expenses of the work. Thirteen planters immediately agreed to contribute this amount, and checks were received from some others after the meeting. Sufficient funds having been raised, a telegram signed by several prominent planters was sent to the Secretary of Agriculture, who approved the plans by telegraph the same day.

The writer proceeded to Cuba as soon as a passport was issued, and through the kindness of Mr. S. G. Chiquelin, superintendent of the sugar factory at Mercedes, Cuba, was able to make his headquarters at the private experiment station of the Cuba Cane Sugar Corporation. The director of the station, Sr. M. A. Centurion, received him cordially and gladly coöperated in every way possible. On July 12, the first sending of parasites was forwarded to Mr. E. R. Barber, of the Bureau of Entomology, and Mr. W. G. Taggart, assistant director of the Louisiana Sugar Experiment Station, who had agreed to receive the parasites at New Orleans. (Mr. U. C. Loftin, who had been in Cuba before, was no longer connected with the investigation.)

Four species of parasites were found, which had also been collected by Mr. Loftin. The egg parasite, *Trichogramma minutum* Riley, already occurs in Louisiana. Of the others, the most efficient is the tachinid, *Euzenilliopsis diatraea* Townsend. The writer estimated that from 20 to 50 per cent of the moth borer larvæ were parasitized, though in one small field the percentage was much higher. The tachinid larvæ emerge usually from the larvæ of the moth borer, but occasionally from the pupæ. Soon after emerging they form puparia, which may be found in the tunnels of the host or nearby between the stalk and the leaf-sheaths of the plant.

As the attack of the moth borer results in the death of young cane

plants, the procedure was to walk through the fields until a dying plant was found, then dissect it carefully and examine it for either a borer or a parasite. The moth borer larvæ and pupæ were taken on the chance that parasites would emerge from a certain percentage of them. Parasite larvæ or puparia were very carefully collected and brought to the laboratory, where the puparia were placed in tin salve boxes with damp sphagnum moss and cotton. The salve boxes were in turn packed in pasteboard mailing cases and sent to New Orleans. At Mr. Barber's suggestion, holes were made in both the salve boxes and the tin bottoms of the mailing cases for ventilation, and it was found that fewer parasites died en route when shipped in this way. About 33 per cent arrived in New Orleans alive. All parasites were sent by ordinary mail, refrigeration not being used.

On reaching their destination, the puparia were placed on damp sand under glasses, and when the flies emerged they were transferred to cages containing growing cane infested with the moth borer. The most successful cage was a large one built over a corner of a sugar cane field. Ripe sweet fruits and honey-water were given the flies, such substances having been recommended by Mr. O. H. Swezey, of the Hawaiian Sugar Planters' Experiment Station, as being satisfactory for a tachinid of similar habits. The parasites passed through two and possibly three generations in New Orleans.

Of the other two parasites in Cuba, one is *Bassus stigmaterus* Cresson (*Microdus*) and the other *Apanteles* sp. They are comparatively rare, and it was thought best not to attempt to introduce them without further study. During the summer over 650 tachinid puparia, representing about 600 parasitized moth borers, were collected, while the moth borers attacked by the other two parasites amounted to not more than a half dozen by each one.

It was hoped by means of heated greenhouses to cause the tachinids to breed continuously through the winter, and two greenhouses containing growing cane were provided, but by December it became evident that the parasites were in a dormant state. On December 2 one puparium was found in a field cage, but the fly did not emerge and it seems that the insect is dead. It is believed that other parasites are present within the host larvæ and will emerge in the spring.

If the parasites become established in Louisiana and are as efficient there as they are in Cuba where they have to contend, by the way, with a secondary parasite, they will do much to control a pest which causes a serious loss annually. With a maximum infestation of the moth borer, it has been calculated both by entomologists and by sugar planters that the annual loss amounts to over 1,000 pounds of sugar per acre. Investigations to be published in Department Bulletin No.

746 show that the average infestation is about 50 per cent of the maximum, which roughly gives a loss of about 500 pounds of sugar per acre on the area infested, which amounts to some 300,000 acres in Louisiana alone. The total annual loss would thus be 150 million pounds, valued during pre-war times at about \$7,000,000. This means that if the insect were controlled the Louisiana sugar planters would make approximately that much more sugar every year, or about one-fourth more than the average crop. There is also considerable damage to corn in Louisiana and to corn and sugar cane in Texas and Florida which has not been estimated.

A system of control by the native egg parasite, *Trichogramma minutum*, has already been found satisfactory to some extent. It has been the custom on the plantations to burn the leaves of the sugar cane plant which are left on the field after the stalks are cut and carried to the mill. This burning probably results in killing vast numbers of the egg parasite without a corresponding reduction in the numbers of the moth borer. To prevent it, the plowing under of the leaves has been tried for the past six years, a method of cultivation having been perfected in coöperation with the Louisiana Sugar Experiment Station, and it has been found that the infestation by the moth borer is never increased by this operation but may be considerably reduced, while the benefit to the soil is very marked. The cost of the additional labor required has been estimated by plantation managers to be less than one dollar per acre, and considering the fertilizing value of the leaves it really amounts to nothing at all.

By avoiding the destruction of beneficial insects and by adding one or more larval and pupal parasites to the very efficient egg parasite already present, it is believed possible ultimately to obtain a fair degree of control.

METHODS IN ENTOMOLOGICAL FIELD EXPERIMENTATION¹

By W. P. FLINT, C. F. TURNER and J. J. DAVIS

The accuracy and value of results from field experiments, whether they be experiments in agronomy, in entomology or other agricultural subjects, depend largely, and in most cases wholly on the accuracy and reliability of the methods used in obtaining the data.

The past year the writers have been associated in the Hessian fly problem and have found it necessary to work out ways of obtaining data and to check and recheck the various methods to determine the most accurate and satisfactory from all standpoints. Although most

¹ Published by permission of the secretary of agriculture.

of these problems pertained to our work with the Hessian fly, they have a greater or less bearing on other entomological problems, especially entomological problems of the corn and grain fields, and the summarized results are here offered for the benefit of others working on similar problems; also with the hope that any inaccuracies in our work may be pointed out to us in order that a standard may be established which will enable one to more easily compare work done by investigators in different parts of the country.

METHODS OF MAKING COMPARATIVE COUNTS OF INFESTATION

In the fall of 1917 several methods were tried¹ in an infested wheat field at Virden, Ill., to determine means of obtaining accurate records of infestation. Three systems were tried: the picking method, the linear yard method, and half square yard. The first mentioned consisted in stooping down and picking a plant at one side, one on the opposite side and one in front or behind, in all cases the plants being taken at random; this taking of three plants to be repeated after walking about ten steps. In picking it was necessary to take the plant from the side and not allow the hand to pass over the tops of the plants in selecting one, since the uninfested plants are usually higher and an inaccurate count will be obtained. Fifty plants were taken in this way. By the second method, five linear yards were selected by tossing a trowel five or ten yards ahead and examining all plants in the yard from the point of the trowel. The half square yard was similarly selected except that only two (= one square yard or five linear yards) were taken.

The results were as follows:

TABLE I—RESULTS OF COUNTS BY DIFFERENT METHODS, 1917

Method	Total Distance of Wheat Row	Number Plants	Number Infested	Percentage of Infestation
Picking method		50	8	16
5 linear yards	15 feet	134	12	8.9+
2 half square yards	15 feet	183	15	8.2—

From a general survey the actual infestation was 12 to 15 per cent, and of the three methods used the picking method in this case gave the best results.

This fall (1918) more thorough counts were made² at Virden, Ill. In order to determine as nearly as possible the actual infestation of the plot, every other yard of two wheat rows, one on each side of the

¹ By Flint and Davis.

² By Flint, Turner and Davis.

small plot being used, were dug up and examined. A total of 71 yards or 1983 plants (average of 9.3+ plants to the foot or 694,468 to the acre, if rows are 7 inches apart) were actually dug up and examined. The accumulative percentages every five yards were as follows: 31+, 27+, 33-, 33+, 35+, 34+, 33-, 32+, 32-, 31+, 30+, 29+, 29+, 29-, 29-, the average for the total 1983 plants being 29-per cent, which we can consider as the average percentage of infestation of the plot.

The various methods were tried to determine the most satisfactory means of making counts and these included the picking method, one-third square yards, linear yards, and linear feet. The results are tabulated in Table II.

TABLE II—RESULTS OF COUNTS BY DIFFERENT METHODS, 1918

Method Used	Taken by	Total Distance of Wheat Row	Number Plants Examined	Number Infested	Per Cent of Infestation	Average Per Cent of Infestation
3 linear yds.	Flint & Davis	9 ft.	76	19	25	25
2 third sq. yds.	Flint & Davis	10 "	98	26	25.5+	25.5+
10 linear feet	Flint & Davis	10 "	140	38	27.1+	28.9+
10 feet linear	Turner	10 "	119	37	31.0+	
Picking method	Flint		50	15	30	29
Picking method	Davis		50	14	28	
2 rows alternate yds.	Turner, Flint & Davis	213 "	1983	571	29. -	29. -

Although none of the methods used were far from correct, the linear foot and picking methods were most nearly accurate and from other tests, repeated at a number of our other sowing plots, they are more to be depended upon. This is as might be expected, since a larger number of small areas scattered over the field should give more nearly accurate results from the entire field than the same total area taken at fewer places in the field. Of the two most accurate methods just mentioned the picking method has been dismissed as the least satisfactory for experiment plots, first, because it requires some practice, second, because it is practically useless in the spring or even in the fall, if the wheat plants have tillered abundantly, and third, because it is desirable to use the same method in fall and spring. Since the linear foot method lacks the disadvantages just named, and is simple, requiring no previous practice, and is practically as accurate as any other means, we have concluded that it is the most correct and satisfactory.

On the other hand, the picking method is very useful for hastily determining fall infestations when making surveys over large areas and for this purpose can frequently be used to advantage.

In many cases it is possible to obtain relatively accurate data by examining plants from above and without digging them up to determine

percentage of infestation, but this method should not be used where accurate records are desired and especially in experiment plots where it is of much importance to determine the stages of the insect, severity of infestation, etc. Likewise this method cannot be used where the wheat has made a heavy growth, for frequently an infested plant will send up new shoots and it is often impossible to determine whether such tillers are individual plants or simply tillers of an infested plant, thus again showing a possible source of error if infestations are secured by simple examination of the plants as they appear above ground.

Summarizing we are led to conclude that the above-ground appearance of plants should be used only in generalizing the infestation, such as heavy, medium or light; that the picking method should be used only for fall scouting work when estimating Hessian fly infestations; and that for experimental plots where simplicity, accuracy and comparableness are essentials, the linear foot method should be followed and that at least ten linear feet be taken from each plot where counts are required.

METHOD OF TAKING YIELDS

While the problem dealing with the accuracy of obtaining yields from small plots is largely agronomic, it is as important for the entomologist as for the agronomist to be familiar with the most accurate and practicable means of obtaining these data.

Various methods have been practiced. Some agronomists insist that reliable records can be obtained only by harvesting the entire plots. Others believe equally reliable or even more accurate yields can be obtained by harvesting only small areas from each plot, usually about one-thousandth of an acre. In taking such small areas as one-thousandth of an acre, some prefer to take so many linear rods of individual wheat rows, while others take so many square yards.

Another year it is hoped that we may have the use of a portable threshing outfit in order to make a comparison of the different methods, but up to the present time we have not had this opportunity and wish simply to place on record the method which has been practiced in obtaining yields in our Hessian fly sowing experiments and to discuss its possible advantages and disadvantages.

Briefly, the method is to select five square yards from each plot, this to be bagged, shipped to a central point and there threshed, weighed and graded. Probably the most important point to be considered in securing yields from such small areas is the selection of the square yard. Observations indicate that selecting the areas by the hoop or other similar method which depends on chance is not accurate when as few as five square yards are to be taken. A fairer way is to

examine the plot and to select typical square yards, thus if one-fifth of the plot has a thin stand and the other four-fifths is heavy, we should select one square yard from the thin and four from the thicker area. One must, of course, be thoroughly unbiased in making his selections. Having selected an area, a yard stick is placed along one row. Having cut this row, the corresponding yard on the next row is cut and so on until five rows or approximately one square yard is taken. (Pl. 7, fig. 1.) Five such areas are cut from each plot, cured, placed in bags and shipped to a central point for threshing. The data taken includes not only weight of straw and grain, but also the grain is tested and its quality recorded, for we find the Hessian fly is responsible for damaging the quality as well as the yield of wheat.

As stated, we have no proof that one means of obtaining yields is better than another and indeed it appears that the practice just described does give us records above the actual yields, but we have every reason to believe, and much proof to show that the method we have used is comparable, which after all is the most important item.

METHOD OF ESTIMATING INJURY

Estimates of injury by this or that insect are frequent in entomological literature, but seldom if ever have the methods used in estimating the injury been noted. No rules can be given to fit all cases. Certain methods which we have used are here offered, with the object of securing expressions of opinion and additional ideas from the members of this association.

Estimating the injury where acreages are killed outright is comparatively simple, but where injury is inconspicuous the difficulties are evident. In the former category we may include damage by white grubs, army worms, grasshoppers and chinch bugs when attacking corn, while in the latter group would be included injuries by scale insects, corn root aphids, Hessian fly, chinch bug in wheat, and joint worm.

In some cases where the insect damage is restricted to a definite area, it is possible to obtain an accurate estimate of injury by comparing yields of this area with a similar uninfested area in previous years as well as the year of injury, consideration being given to the climatic conditions in the two areas. Where the injury is widespread we know of no other method than comparing the yields during the season of insect injury with previous seasons yields, due weight being given insect injuries in previous years, and comparableness of climatic conditions and acreage. In estimating injuries where the damage is evident, the percentage of injury can be corroborated to a certain extent by a general survey and careful estimate of individual fields,



1. Method of cutting square yards of wheat to determine yields in sowing plots. Five such square yards are taken from each plot.



2. Hand flailing and fanning wheat, the method adopted in the absence of a more modern threshing outfit. The hand method is apparently accurate but very tedious.

but this is more difficult and less satisfactory with insect damage by such as the Hessian fly and joint worm. In the latter cases we can compare with previous years, but we have no basis to estimate accurately the injury in individual fields since there is no reliable comparison between infestation and injury. In the case of the fall injury by Hessian fly, the damage can be estimated only when the infestation is severe and the plants killed outright and in the case of spring injury by fly and by the wheat joint worm we do not know just how much or even the approximate damage by the insects. It is planned to get positive data on these facts another year for the joint worm and Hessian fly by enclosing large areas during the oviposition period of the fly and joint worm, two to be kept free from infestation and two to be infested by the introduction of joint worm adults and Hessian fly, respectively. It is to be hoped that others may be in a position to repeat these experiments and to make similar tests with other insects.

CONTINUITY OF INVESTIGATIONS

In order to secure reliable results it is important, and in the cases of such insects as the Hessian fly and corn root aphid, absolutely necessary, to continue the experiments over a period of years. This is well illustrated in the 1918 Hessian fly sowing experiments. Should we base our conclusions on this single season's results, our recommendation for fall sowing of wheat would be inaccurate since the fly-free date in 1918 was earlier than normal.

Continuity of observation is also very necessary in assisting the entomologist to predict the likelihood of an insect outbreak a following year and to determine the seriousness of such a possible outbreak. Thus a study of the likely hibernating quarters of the chinch bug in a certain section of the country extending over a comparatively large area and for several consecutive years is necessary to enable the entomologist by surveys from fall to fall, to determine with reasonable accuracy, the probabilities of a chinch bug outbreak and the extent and degree of the likely infestation the following season.

ELEODES OPACA SAY, AN IMPORTANT ENEMY OF WHEAT IN THE GREAT PLAINS AREA¹

By JAMES W. McCOLLOCH, *Associate Entomologist, Kansas State Agricultural Experiment Station*

Although the false wireworm, *Eleodes opaca* Say, was described in 1823 (Say, 1823, p. 263) it was not recognized as an insect of economic

¹ Contribution from the Entomological Laboratory, Kansas State Agricultural College, No. 38. This paper embodies some of the results obtained in the prosecution of project No. 100 of the Kansas Experiment Station.

importance until 1908. In the fall of that year several instances of injury were noted in western Kansas and considerable injury occurred in southwestern Nebraska (Swenk, 1909). Since the first recognized outbreak in 1908 there have been three well-marked outbreaks and reports of minor injury have been received every year. With the increasing importance of this insect it was deemed advisable to undertake a study of its life economy and accordingly in 1915 it was incorporated in one of the experiment station projects. The life-history has been thoroughly worked out, and insofar as time would permit, field studies have been made.

DISTRIBUTION

Eleodes opaca has a wide distribution throughout the Great Plains area. Blaisdell (1909, pp. 177-178) records it from Texas, Oklahoma, Kansas, Nebraska, Colorado, and South Dakota. Wickham (1899, p. 60) reports it from Lyon County, Iowa. Fall and Cockerell (1907, p. 204) list it from Coolidge, New Mexico, and Evans (1903, p. 318) says it was taken in the Northwest Territories in 1879-80. Prof. R. A. Cooley recently furnished the writer with a single female taken at Culbertson, Montana.

In Kansas, this species is generally distributed over the western two-thirds of the state. Popenoe (1877, p. 36) says it occurs from Louisville westward. In the vicinity of Manhattan it is found in rather limited numbers and increases in numbers as one progresses westward across the state.

HISTORY AND IMPORTANCE

Previous to 1908, *Eleodes opaca* was not recognized as an insect of economic importance. It was known to occur in large numbers in the native grass lands throughout the Great Plains area but had never been mentioned as injurious. In the fall of 1908, a large number of worms, reported to be seriously injuring germinating wheat in western Kansas, were received by the Department of Entomology and determined as tenebrionid larvæ. According to Swenk (1909) severe damage also occurred in several Nebraska counties. He determined the larvæ as *Eleodes opaca*.

During 1909 and 1910 a few specimens of false wireworms were received with the information that they were doing a slight amount of damage to fall sown wheat. In the fall of 1911 a well-marked outbreak of this insect occurred in western Kansas, resulting in the destruction of several thousands of acres of wheat.

Again in the fall of 1914 and the spring of 1915, considerable injury was reported in several localities. The last and most severe outbreak

began in the fall of 1917, and is still in progress. In Kansas, west of the 98th meridian, the infestation has been general and entire fields have been destroyed. Reports of serious injury have also been received from Oklahoma and northwestern Texas. During the present outbreak the injury has not been confined to wheat, but has included oats and barley and occasionally corn and sorghums.

In all probability this insect has been responsible for much injury to wheat previous to 1908, but has been confused with the true wireworms and other insects. Many of the letters in the files of the Department of Entomology prior to this time refer to wireworms damaging fall sown wheat. From the text of these letters it would seem now that the insect in question was *Eleodes opaca*. In the field investigations the writer has often found the farmers confusing false wireworm injury with that caused by true wireworms, white grubs, fall army worms, Hessian fly, and winter killing.

NATURE OF INJURY AND FOOD

The principal injury by *Eleodes opaca* is done by the larvæ during the fall. At this time they attack the wheat seed immediately after planting and destroy it before germination. During dry years when the grain may lie in the ground several weeks before sprouting, the injury becomes most severe. After the seed germinates the injury becomes less noticeable and often ceases altogether. In some cases, however, considerable damage may occur after the wheat is several inches high. This was especially true in 1911 when the larvæ destroyed many fields by cutting the plants off just above the seed. Occasionally some damage occurs in the spring, due to the larvæ burrowing through the stalks or even cutting them off. The original food of the larvæ was apparently the roots and seeds of native grasses and weeds, but within recent years, due to the breaking out of the native sod, wheat has apparently supplemented this food. In the rearing work the best results have been had by feeding the larvæ wheat seed and bran. Other foods have been used, but in all cases the larvæ either died or made a very slow growth. Aside from wheat it has been possible to rear the worms on sprouting corn, foxtail seeds, and crab grass roots. In one instance larvæ were found feeding on the roots of bindweed in the field. During the present outbreak, serious damage has occurred in the spring to oats, barley, sorghums, and corn. In every case these crops were planted early on land where the worms had destroyed the wheat the previous fall. Wheat is subject to the greatest injury because it is planted at the time when the larvæ are reaching maturity and are voracious in their feeding. Swenk (1909, p. 334) reports larvæ found in ears of corn that had probably fallen on the ground.

Little is known concerning the amount of injury done by the adults. Swenk (1909, p. 336) states that the beetles fed voraciously on corn leaves in the breeding cages. When the experimental work was started, the adults were supplied with various weeds found in the wheat field, but in no case did they feed to any extent and the mortality was high. A few of the beetles fed sparingly on smart weed, dried wheat leaves, and fresh wheat leaves. Wheat heads that were not yet mature were then introduced into the cages and the beetles began to feed on them at once. Later soaked wheat kernels and bran were supplied and they fed on these readily. Mating and oviposition began soon after the change to this food. The fact that the beetles fed on the wheat heads and grain suggests the possibility that they may feed on them in the field, and in fact, recent investigations bear this out since typical injury has been found on wheat in the shock. It is not unusual to find large numbers of beetles about the shocks and stacks of wheat, and in many cases the fall infestation has radiated from such places.

DESCRIPTION AND LIFE ECONOMY

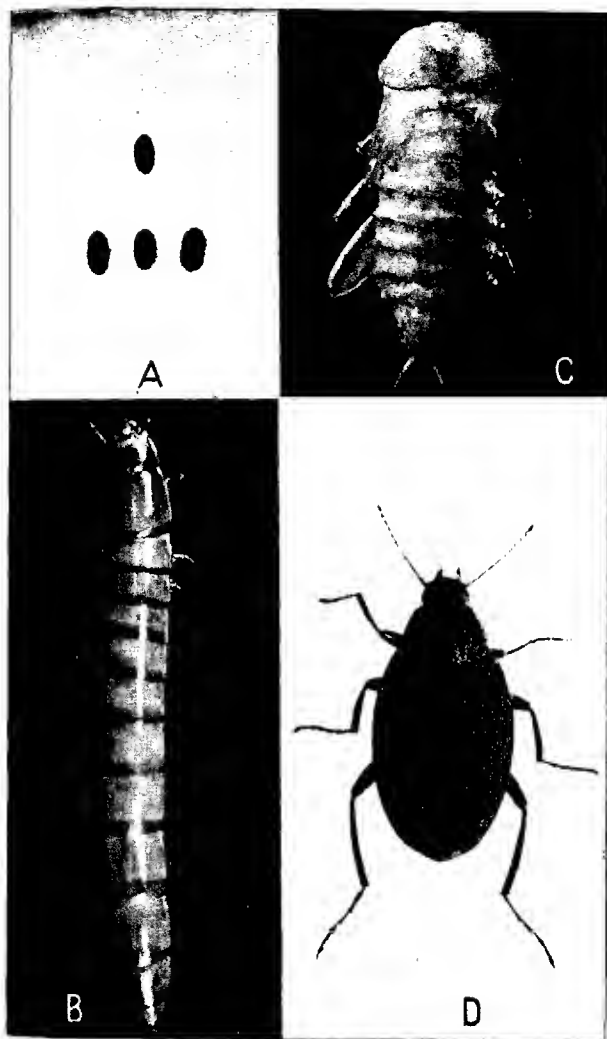
METHOD OF REARING.—The same methods were followed in the rearing of *Eleodes opaca* as were described by the writer (1918, pp. 214–215) for the life-history work with *E. tricolorata*. The eggs were kept in the field insectary while the other stages were kept in a cement cave.

EGG.—The eggs of *Eleodes opaca* (Plate 8, A) closely resemble those described for other members of the genus, being oval in shape longitudinally, and circular in diameter. They show some variation in size, being from 1.1 to 1.4 mm. in length and from 0.50 to 0.65 mm. in width. They are white in color when deposited and change to a creamy yellow before hatching. A sticky secretion covers the egg, causing particles of soil to adhere to it. In the breeding cages the eggs were deposited in cavities in the soil ranging from one inch to five inches in depth.

The length of the egg stage varies with the temperature, and the season of the year. Eggs deposited during midsummer hatched in from 6 to 10 days, while later in the fall the stage was prolonged to 19 days. The first oviposition recorded occurred on July 5, and the last on October 4. The exact length of the egg stage was determined for 993 eggs, as shown in the following table:

LENGTH OF EGG STAGE

Year	No. of Eggs	Min. Days	Max. Days	Average Days
1915	685	7	15	10.0
1916	144	6	19	11.3
1918	164	6	15	7.2
Average				9.7



Eleodes opaca Say: A, Eggs showing soil particles adhering; B, Larva; C, Pupa; D, Adult, female.

LARVA.—As pointed out by Swenk (1909, p. 335) the larva of *Eleodes opaca* (Plate 8, B) closely agrees with the description of *E. dentipes* as given by Blaisdell (1909, pp. 497-499). The minor differences have already been discussed by Swenk, and need no further treatment. On hatching, the larvæ are about 2.8 mm. in length. Growth is comparatively rapid and by fall the worms are about full grown, being from 21 to 23 mm. in length.

The larvæ moult eleven times, including the moult when pupating, between hatching and pupation, the time between moults varying to some extent. An average of the length of each stadium, as determined for six larvæ, is as follows: first stadium, 4 days; second stadium, 3 days; third stadium, 4 days; fourth stadium, 6 days; fifth stadium, 8 days; sixth stadium, 13 days; seventh stadium, 15 days; eighth stadium, 12 days; ninth stadium, 18 days; tenth stadium, 199 days; eleventh stadium, 20 days. In moulting the skin is split on the dorsal side from the vertex back to the first or second abdominal segment, and the old skin is shed by the larva arching the back and drawing the body out, the posterior end emerging last.

The larvæ are subterranean in their habits, and thus far the writer has never observed them on the surface of the ground. Swenk (1909, p. 333), however, cites a case where they were found in large numbers on the surface following a heavy rain. They show a preference for rather dry soil, and usually the majority of the worms are found at the junction of the loose drier soil with the compact moist soil. In the fall they are found at the bottom of the drill rows where they are feeding on the seed wheat. In the spring they are more often located just beneath the surface of the ground, under clods and wind-blown soil. The principal food of the larvæ appears to be wheat kernels, but they also feed on the roots and seeds of native grasses and weeds, and on decaying matter. In the rearing work, the worms thrived best on soaked wheat and bran. During the spring of 1918, considerable injury was also done to germinating oats, barley, corn, and sorghums, where these crops had been planted on infested wheat land. The larvæ also feed on their cast-off skins and on larvæ that are dead or in a weakened condition.

Most of the larvæ become practically full grown by October, and thus pass the winter. Early in the spring they become active, and usually moult once during April. Pupation occurs during the last of April and throughout the month of May. The transformation to the pupal stage is preceded by a semipupal or quiescent state lasting about a week. The length of the larval stage as determined for the several years that the work has been in progress is shown in the following table:

LENGTH OF THE LARVAL STAGE

Years	No. Larvæ	Min. Days	Max. Days	Average Days
1915-16	3	329	355	338.3
1916-17	25	292	329	305.2
1917-18	22	311	346	329.1
Average				317.7

PUPA.—The pupæ of *Eleodes opaca* (Plate 8, C) vary from 13 to 15.5 mm. in length, and from 3.5 to 5.5 mm. in width. They are white in color with semitranslucent appendages. This color changes as development takes place, the body becoming creamy yellow and the appendages reddish brown. In general, the pupæ resemble those of *E. clavicornis* described by Blaisdell (1909, pp. 500-501), with certain modifications noted by Swenk (1909, p. 335).

Pupation occurs in the field during April, May, and June. In 1915, pupation began about April 20, reached its maximum May 4, and was practically over by June 1. The spring of 1918 was cold, and pupation did not begin until May 7. The maximum was reached about May 20, and pupæ were to be found until the last of June. Before pupating, the larva constructs a spherical cell from one-half to two inches below the surface of the ground. Here it remains in a quiescent state for about a week before transforming to the pupa. The length of the pupal stage has been determined for 149 pupæ, the pertinent data being shown in the following table:

LENGTH OF THE PUPAL STAGE

Year	No. Pupæ	Min. Days	Max. Days	Average Days
1915	50	13	25	20.6
1916	4	9	13	11.5
1917	19	8	11	9.6
1918	76	8	23	11.1
Average				14.1

ADULT.—The adult beetles (Plate 8, D) are fusiform oval in shape, black in color, and sparsely covered with whitish hair. The dorsum of the elytra is quite flat. The female is more or less broadly oval in shape and the abdomen is rather strongly convex. The anterior tarsi are unmodified. The male differs from the female in that the body is narrow and the abdomen is but slightly convex. The first two segments of the anterior tarsi are slightly widened and clothed with two dense pads of spongy pubescence. The males are 10 to 12 mm. in length, and about 5 mm. in width. The females are somewhat larger in size, being 11 to 14 mm. in length, and 5 to 7 mm. in width.

Emergence begins about the middle of May, and continues through

June. From this time on until the middle of October the adults are to be found in the field, the greatest number being present during July and early August. The normal length of life for the adult is from two to four months. Most of the beetles under observation lived from 60 to 90 days, while one male lived 130 days. Unlike *Eleodes tricolorata* none of the beetles of this species hibernate over winter, and thus far the writer has never found adults later than October 18. While most of the adults emerged during June in the life-history studies, no mating was observed previous to July 3. During the four years that these studies have been under way, copulation has occurred the first week in July, and oviposition usually follows in two or three days. The first oviposition was noted July 5, and the last on October 4. The period of oviposition, together with the number of eggs per female was determined for seven mated females in 1915, this data being summarized in the accompanying table. Similar studies made the following years gave essentially the same results.

OVIPOSITION RECORD FOR SEVEN FEMALES, 1915

Female No.	Period Oviposition, Days	No. Days on Which Eggs Were Laid	Total No. of Eggs	Ave. No. Eggs Per Day for Period of Egg-Laying	Ave. Per Day for Days on Which Eggs Were Laid	Max. No. of Eggs Laid in 24 Hours
1	59	48	373	6.3	7.7	31
2	46	39	339	8.4	10.0	34
3	11	3	23	2.0	7.6	6
4	27	17	93	3.4	5.4	9
5	18	12	44	2.4	3.6	11
6	35	32	241	7.0	7.5	25
7	14	12	105	7.5	8.3	23
Average	30	23.3	181.1	5.3	7.2	19.3

While matings were observed frequently in all cages, the presence of the male was not necessary after fertilization once took place. In the case of female No. 1, the male died July 18, but she continued to deposit fertile eggs until September 6. The proportion of sexes as determined from reared and collected adults indicate that the females are slightly in excess of the males. Fifty-six per cent of the beetles taken in the field have been females, while 54 per cent of the reared beetles were females.

The adults of *Eleodes opaca*, like many of the other members of the genus *Eleodes*, are more or less nocturnal or crepuscular in their habits. In the field they are generally most active early in the morning, and about dusk in the evening, while during the hotter parts of the day they are to be found hiding under any suitable covering. In the prairie lands, rocks, manure, piles of weeds, and clumps of grass offer ideal hiding places, while in the wheat fields they are to be found under shocks and around stacks of wheat, under Russian thistles, in clumps of volunteer

wheat, and, in fact, any place where there is protection. It is not unusual to find them in large number under piles of Russian thistle that have collected along a fence. They also probably make use of the burrows of the various insects, and animals common to their locality. Snow (1877, p. 19) found twenty adults under bones near Colorado Springs, Colorado.

The adults apparently have a wide range of food habits. In the field they have been found feeding on evening primrose, Russian thistle, and alfalfa. In the rearing cages they fed sparingly on smart weed and on wheat leaves, while they showed a great preference for heads of wheat, soaked wheat and bran. Examinations made in the field indicate that they may feed on the wheat in the stack and shock, especially if it becomes damp. When confined on a small plot of young wheat they destroyed it in a few days. In one case a beetle was found feeding on a nymph of *Melanoplus differentialis*, but it was impossible to determine whether it had killed the grasshopper or not. It is not unusual for them to feed on the dead or weakened members of their own kind.

LENGTH OF LIFE-CYCLE

Three generations of this insect have now been reared from adults collected in the field in 1915. Each generation has occupied about one year and the data secured in this study coincides very closely with the field observations. Taking the average length of the various stages, each brood required 341 days from the time the eggs were laid until the adults emerged. The essential data showing the length of the life-cycle are summarized in the following table:

SUMMARY OF THE LENGTH OF THE LIFE-CYCLE

Stage	Minimum Days	Maximum Days	Average Days
Egg	6	19	9.7
Larva	292	355	317.7
Pupa	8	25	14.1
Life-cycle	306	399	341.5

ENEMIES AND PARASITES

Very few natural enemies are known to attack *Eleodes opaca*. Bruner (1892, p. 12) records finding the eggs of a tachinid on the elytra. Each year that these studies have been carried on a few beetles have been collected in the field from which have been reared specimens of the hymenopterous parasite, *Perilitus eleodis* Viereck. In no case has the percentage of parasitism been high, and the relation of this parasite to *opaca* has been given but little attention. From the notes at hand, the behavior appears to be the same as in the case of *Eleodes*

tricostata (McColloch, 1918, pp. 221-222). A gregarine (*Stylocephalus giganteus* Ellis) has frequently been found in the alimentary tract of the adults.

Swenk (1909, pp. 335-336) encountered considerable difficulty in his rearing work, due to the presence of what was apparently a bacterial disease. This disease usually began as a small dark red spot on the thoracic segments, or on the terminal abdominal segments, and spread rapidly, soon encircling the body, resulting in the death of the larva. Where several larvæ were confined in the same cage, the disease often spread to the others. The writer has often encountered this same disease, but since the larvæ were reared in separate boxes, it never spread to any extent. Two species of fungi have been found attacking the larvæ, namely, *Sporotrichum globuliferum* and *Metarrhizium* sp.

PHYSIOLOGICAL RELATIONS

Eleodes opaca is a typical species of the Great Plains, an area of low rainfall and rather high temperatures. While it has been recorded as far east as Iowa, it does not occur in large numbers east of the 98th meridian. It is not common to the vicinity of Manhattan, being found only on the high, grassy uplands. The years of greatest injury in western Kansas have been characterized by excessive temperatures and low rainfall. In the life-history studies, eggs, kept in cages where the maximum temperature during the day was 112°, and the relative humidity 25 per cent, hatched in six days. The adults were not affected by a daily temperature of from 105° to 112° when the humidity was low. In ovipositing, the adults showed a preference for dry soil, and the rate of egg-laying decreased when the beetles were placed in cages containing moist dirt. Some moisture, however, is required by the adults, and this was supplied by feeding wet bran once a week. The larvæ thrived best in a slightly moist soil. When the soil was too wet to crumble nicely, the mortality increased rapidly. High temperatures, such as experienced by the eggs and adults, were fatal to the larvæ and the best results were had by keeping them in a cave where the temperature remained constant at about 80° during the summer, falling slowly to 39° in midwinter. There is some evidence that the larvæ can withstand low temperatures, and Swenk (1909, p. 334) cites a case where they survived a twelve-hour exposure to a sweeping wind of from 59 to 72 miles an hour velocity, with the temperature about zero.

Like most of the species of the genus, the adults of *opaca* are negatively phototropic to strong light. During the day they are usually to be found hiding under various types of shelter, confining most of their activities to the early morning, evening, and night. The larvæ

are subterranean in their habits, and when placed on the surface of the ground they immediately burrow into the dirt.

CONTROL

Thus far it has not been possible to carry out any extensive experiments on the control of *Eleodes opaca* in the field. The measures advocated are based on a study of the history of over 200 infested fields obtained through personal visits, and from questionnaires furnished to the farmers. In most cases the history of the field has been obtained for the preceding two or three years. A study of the data thus secured suggests several promising methods of procedure which have proved beneficial in controlling or reducing the amount of injury.

ROTATION.—The investigations in many fields infested by false wireworms show that in nearly all cases the greatest injury has occurred on land continuously cropped to wheat, while fields that have been in a row crop or fallowed previous to wheat have suffered little damage. The beetles are wingless, and migration from field to field must take place on foot. These facts indicate that a careful rotation of crops, combined with certain other practices to be mentioned later, would eliminate much of the damage and the writer has seen many fields where this has been the case. In following a system of rotation in western Kansas, it must be remembered that the number of crops that can be alternated with wheat is limited principally to feed crops such as sweet sorghums, kafir, milo, and feterita, and, under certain conditions, corn. Occasionally oats and barley are included, and many farmers practice a rotation whereby a small grain crop is planted early in the spring on land where the worms have destroyed the wheat crop the previous fall. Such a system usually increases the injury since it provides additional food at a time when the larvæ are maturing. Where the fall wheat has been destroyed, the land should be worked about the first of May and planted to a row crop. If the field is kept cultivated and free from weeds and grasses, it is often possible to return the land to wheat in the fall. This is not always feasible, since the feed crops are late maturing, and in this case oats or barley should be planted in the spring to be followed by wheat in the fall. Call and Salmon (1918, pp. 42-43) suggest the following rotation for western Kansas: wheat two years; kafir or other sorghums, one year; and summer fallow, one year. By this system, one-half of the farm is in wheat each year, one-fourth in a feed crop, and one-fourth is fallowed for the next wheat crop. Such a system, if carefully followed, would reduce the false wireworm injury and at the same time increase the yield.

SUMMER FALLOW.—The practice of summer fallow whereby the land lies idle for a year, being worked sufficiently to keep down the plant

growth, is practiced to a limited extent in western Kansas. Where this method is followed there has been little or no injury from false wireworms. Summer fallowing deprives the beetles and larvæ of food, and destroys many eggs. The beetles are also deprived of shelter during the day. This method of handling the wheat land is somewhat more expensive than the usual methods, but the yields are generally ample to encourage its use.

WEEDS AND VOLUNTEER CROPS.—During the summer months, large numbers of adults are to be found hiding under Russian thistles and in clumps of volunteer wheat and oats in the fields. The keeping down of these plants will deprive the beetles of shelter, and cause them to seek protection elsewhere, and will also serve to deprive the larvæ and adults of food. Heavy growths of weeds and grasses along the roadsides and fence rows should also be kept down during the summer.

TIME OF PLANTING.—Some injury can be avoided by delaying the planting of wheat in the fall, although as a rule late planting does not yield as well as early sowing. The larvæ usually ceased their activities during the latter part of October, and wheat planted after the middle of this month will be less subject to injury. With regard to the time of planting, it might be stated that with favorable conditions, such as a well-prepared seedbed, good seed, and plenty of moisture, seeding may be made moderately early. On the other hand, if the season is dry and the seed may lie for some time in the ground before germinating, it is advisable to delay the planting. The larvæ are most active in a dry, loose soil, and the greatest injury has occurred in those years when the summer and fall have been dry.

In the case of spring crops, planting should be delayed until about the first of May, at which time most of the larvæ have reached maturity and are transforming to pupæ. This is especially to be recommended when the crop is to be planted on land where the wheat has been destroyed by the worms.

SPRING PLOWING.—The practice of plowing or listing infested fields early in May will destroy large numbers of pupæ by breaking up the pupal cells, and crushing the pupæ or by exposing them to natural enemies and climatic conditions. The writer has been in many fields where this has been done, and in every case from 80 to 95 per cent of the pupæ were destroyed. This method can be followed where the larvæ have destroyed the wheat and it is planned to plant sorghums or corn.

STACKING vs. SHOCKING.—Examinations made in fields where the previous wheat crop was shocked often show more injury than where the crop was stacked. In other words, the shocks provide shelter for the beetles in all parts of the field, and instead of the outbreak being

confined to one part of the field, it is general over the entire area. When the grain is stacked at harvest, the infestation often radiates out from the stack, indicating that the beetles have congregated there.

POISON BRAN MASH.—The use of the poison bran mash as prepared for use against grasshoppers may prove beneficial in some cases in the control of *Eleodes opaca*. Under laboratory conditions the beetles ate it voraciously, and were attracted to it from a distance of two or three feet. The possibility of its use under certain conditions where the adults are congregated in large numbers around wheat shocks and stacks, and piles of Russian thistles may prove practical. Experiments in poisoning the larvæ have thus far given negative results.

LITERATURE CITED

- BLAISDELL, F. E. 1909. A Monographic Revision of the Coleoptera Belonging to the Tenebrionid Tribe Eleodini Inhabiting the United States, Lower California, and Adjacent Islands. U. S. Nat. Mus., Bul. 63, 524 pp.
- BRUNER, L. 1892. Report Upon Insect Depredations in Nebraska for 1891. U. S. Dept. Agr., Div. Ent., Bul. 26 (O. S.), pp. 9-12.
- CALL, L. E., and SALMON, S. C. 1918. Growing Wheat in Kansas. Kan. Agr. Exp. Sta., Bul. 219, pp. 3-51.
- EVANS, J. D. 1903. List of Canadian Coleoptera. Can. Ent., 35: 239-243, 288-292, 317-320.
- FALL, H. C., and COCKERELL, T. D. A. 1907. The Coleoptera of New Mexico. Trans. Amer. Ent. Soc., 33: 145-272.
- MCOLLOCH, J. W. 1918. Notes on False Wireworms with Especial Reference to *Eleodes tricosata* Say. Jour. Econ. Ent., 11: 212-224.
- POPEÑO, E. A. 1877. A List of Kansas Coleoptera. Trans. Kan. Acad. Sci., 5: 21-40.
- SAY, T. 1823. Descriptions of Coleopterous Insects Collected in the Late Expedition to the Rocky Mountains, Performed by Order of Mr. Calhoun, Secretary of War, Under the Command of Major Long. Journ. Acad. Nat. Sci. Phila., 3: 139-216, 238-282.
- SNOW, F. H. 1877. List of Coleoptera Collected in Colorado in June, July, and August, 1876. Trans. Kan. Acad. Sci., 5: 15-20.
- SWENK, M. H. 1909. *Eleodes* as an Enemy of Planted Grain. Jour. Econ. Ent., 2: 332-336.
- WICKHAM, H. F. 1899. *Eleodes* in Iowa. Proc. Iowa Acad. Sci., 7: 59-60.

EXPERIMENTS WITH POISON BAITS AGAINST GRASSHOPPERS¹

By D. A. RICKER, *W. LaFayette, Indiana*

During the past season grasshoppers were abundant and caused considerable damage to clover, alfalfa, tobacco and other crops in the vicinity of southern Wisconsin. Especially were they abundant in

¹ Published by permission of the Secretary of Agriculture.

the vicinity of Janesville, where the writer was temporarily located, and where conditions afforded an opportunity to test different combinations of poison bait under varying climatic conditions. The results thus obtained indicate that certain changes in the present standard formula might be made to advantage, that climatic conditions play an important rôle in the efficacy of poison baits, and that mature and immature grasshoppers are attracted to odorous baits unequally.¹ While the results are not conclusive and do not warrant changes in recommendations, they show definite tendencies which we believe should be taken into consideration by entomologists who contemplate grasshopper experiments a following season.²

ATTRACTIVENESS OF DIFFERENT BAITS

In one series of four experiments made August 29, to determine the relative attractiveness of various baits, fifteen combinations based upon the standard formula (bran, fruit, molasses, water and poison) were tried, but each contained a different attractive element. These experiments were conducted simultaneously at four points in an equally infested field of barley stubble, each at least a quarter of a mile apart. The baits were placed in small piles, containing about half a handful, six feet apart, and the application completed by 7 a. m. Observations were made at half-hour intervals from 8 a. m. until 3 p. m., and include a record of the number of grasshoppers and crickets either actually feeding, or within a radius of six inches of the pile.

The combined results of these experiments are as follows: apples alone, 71 hoppers and 37 crickets; molasses and bananas, 53 hoppers and 30 crickets; molasses alone, 52 hoppers and 48 crickets; bananas alone, 46 hoppers and 23 crickets; salt alone, 45 hoppers and 33 crickets; molasses and apple, 40 hoppers and 30 crickets; lemon fruit, 38 hoppers and 25 crickets; lemon extract, 38 hoppers and 41 crickets; molasses and salt, 32 hoppers and 14 crickets; molasses, salt and lemon extract, 31 hoppers and 40 crickets; molasses, salt, and lemon fruit, 31 hoppers and 30 crickets; salt and bananas, 27 hoppers and 35 crickets; molasses and lemon extract, 20 hoppers and 34 crickets; with molasses, salt and apple coming last in this series with a total in three of the four experiments of 19 hoppers and 5 crickets. This last observation of apple with salt and molasses is not comparable with the other results for in one experiment this bait was omitted by mistake, and

¹ In the vicinity of Janesville, Wis., *Melanoplus femur-rubrum*, *M. attalis*, and *M. bivittatus* predominated, and nearly all were nearly mature at the time of the experiments.

² The writer wishes to acknowledge suggestions and kindly criticism received from J. J. Davis.

also because in one of the three experiments in which it was used it was placed in a slight depression which undoubtedly gave an unfair result.

A single earlier experiment on August 22, using ten baits under similar conditions but in another part of the same field gave the following results: apple, molasses and salt, 14 hoppers and 6 crickets; apple and molasses, 13 hoppers; molasses alone, 8 hoppers and 4 crickets; apple alone, 7 hoppers and 1 cricket; lemon extract alone, 7 hoppers and 1 cricket; lemon fruit and molasses, 6 hoppers and 1 cricket; banana alone, 6 hoppers; molasses, lemon extract and salt, 6 hoppers; salt alone, 3 hoppers; lemon extract and salt, 2 hoppers.

The above observations are summarized in the following table:

SUMMARY OF RESULTS OF ATTRACTIVENESS EXPERIMENTS

Exp. No.		No. Hoppers	No. Crickets
1. Bran	Apple	7	1
2. Bran	Banana	6	
3. Bran	Lemon extract	7	1
4. Bran	Salt	3	
5. Bran	Salt Lemon extract	2	
6. Bran Molasses		8	4
7. Bran Molasses Lemon		6	1
8. Bran Molasses	Apple	13	
9. Bran Molasses	Salt Lemon extract	6	
10. Bran Molasses	Salt	14	6
11. Bran Molasses		52	48
12. Bran	Lemon	38	25
13. Bran	Lemon extract	36	41
14. Bran	Apple	71	37
15. Bran	Banana	46	23
16. Bran	Salt	45	33
17. Bran Molasses Lemon		31	25
18. Bran Molasses	Lemon extract	20	34
19. Bran Molasses	Apple	40	30
20. Bran Molasses	Banana	53	30
21. Bran Molasses	Salt	32	14
22. Bran Molasses Lemon Salt		31	30
23. Bran Molasses	Salt Lemon extract	31	40
24. Bran Molasses	Salt	19	5
25. Bran Molasses	Salt	27	35
Total number recorded		644	461

These experiments indicated that apples and bananas when used alone or with molasses are as attractive or slightly more so than lemon fruit or lemon extract.

Actual control experiments testing these various combinations all gave satisfactory results with mortalities varying from 60 to 98 per cent. In a series of baits sown on August 20, one containing apples and molasses gave, at the end of five days, an average count of 40 dead hoppers to the square yard, or approximately 75 per cent. A bait containing lemon fruit and molasses, but sown in an area containing a

slightly heavier infestation gave an average of 50 dead hoppers to the square yard or approximately 75 per cent. Lemon fruit and salt gave practically the same results as molasses and salt with average square yards showing from 35 to 40 dead hoppers or about 70 per cent. In this series salt alone resulted in an average of 30 dead hoppers to the square yard or about 65 per cent, while molasses alone gave 28 dead hoppers to the square yard, or about 60 per cent.

These experiments further show that apples and molasses gave practically the same results as lemon fruit and molasses; that lemon fruit and salt gave practically the same results as molasses and salt, but that both were slightly less effective than the first two combinations. Salt alone seems to have given slightly better results than molasses alone.

Another series on September 3 resulted in banana alone obtaining a kill of 35 to 40 hoppers to the square yard or approximately 85 per cent, while apple alone resulted in from 25 to 30 dead to the square yard, or about 75 per cent. Molasses alone, at the usual rate, gave 48 dead to the square yard, or approximately 90 per cent, while molasses alone, at double strength, but sown in standing corn, gave a kill of 15 to 20 hoppers to the square yard, or 85 per cent of the infestation.

Grasshopper injury to tobacco shows up as holes in the tobacco leaves. This makes the tobacco useless as binder tobacco and results in a very low price for the crop. Since a small infestation can in a very short time eat holes in a considerable amount of tobacco, the use of something which will give a quick and maximum kill means a considerable saving. In several experiments bananas were substituted for the lemon fruit in the standard bait, applications being made under similar conditions and in all cases the banana gave as good results as the lemon fruit and seemed to give a heavier early mortality. This indicates that banana might be of special value when treating tobacco which, this year in southern Wisconsin was estimated as being worth \$450 an acre.

PERIOD OF ATTRACTIVENESS OF DIFFERENT FRUITS

One marked difference between the citrous and non-citrous fruits, such as apples and bananas, is that citrous fruits become flat within a day or two after application, whereas the non-citrous fruits mentioned above increase in odor and attractiveness as fermentation progresses. This factor should make baits attractive for more than the one or two days during which the citrous baits are effective. Grasshoppers and crickets have been observed feeding upon the non-citrous baits as late as the eleventh and twelfth days after application, although no hoppers could be found at that time feeding upon the citrous baits

which had been sown at the same time. If, as is sometimes the case with citrous baits, an efficient kill has not been obtained within a few days, the materials and labor represent an almost complete loss, whereas with non-citrous fruits the odor becomes stronger, and even when the bait has been completely dried out, a slight mist or dew will cause the non-citrous baits to again become odorous and attractive, and consequently not a complete loss, even though the initial kill had not been high.

RELATIVE ATTRACTIVENESS OF MATURE AND IMMATURE GRASSHOPPERS TO ODOROUS BAITS

As the majority of the grasshoppers recorded in these experiments were adults, the question arises as to whether these baits would prove equally effective against immature grasshoppers. The writer's observations seem to show that the younger hoppers are much more susceptible to a highly odorous bait. In three control experiments on July 23, at which time a considerable portion of the hoppers were in the third and fourth instar, a very efficient kill was obtained by the addition of half an ounce of lemon extract to the standard formula. It was originally intended to use the lemon fruit alone, but the lemons did not make the mixture especially odorous so the extract was added. This gave a very efficient kill of from 85 to 90 per cent of the infestation.

In comparison with the above we have the results of four experiments on August 6, under approximately the same conditions. Here lemon fruit was used in the standard bait at the rate of five fruits to 25 pounds of bran. The hoppers were still in the third and fourth instars with a few adults. The results from these experiments show not more than a 65 per cent mortality, and this included mostly fourth instar and adult hoppers. This difference in efficiency compared with the earlier experiment, which gave a 90 per cent mortality, is marked and would indicate that young hoppers responded better towards the more odorous bait. This suggests that there may be considerable variation between the attractiveness of a certain bait to the younger in comparison with the more mature hoppers. It is believed that had lemon extract been added to the bait in this second series the results would have been much more efficient.

EFFECT OF CLIMATIC CONDITIONS ON THE EFFICIENCY OF POISON BAIT

A rather low temperature and a high humidity such as one finds immediately after a storm, appears to be ideal for a rapid and maximum mortality. In one experiment an application of four different baits, containing three different poisons, was made following a night of heavy

rain and wind, with considerable thunder and lightning. The rain ceased about 4.30 a. m. and the application was made at 5 a. m. At that time the temperature was 61° F. and the humidity 96 per cent. The average temperature for the five days following the application was 69.34° F. compared to a monthly average of 74.85° F. The average humidity for the period was 77.2 per cent compared to the monthly average of 73.93 per cent. The daily average atmometer reading for the period was 9.66 cc. compared to an average for the month of 24.58 cc. The application covered about 20 acres, five of which were in tobacco. About one third of the tobacco had been so severely injured that only the stalks and stems remained. At the end of the two days following the application the mortality was found to have reached as high as 90 to 95 per cent. At the end of the five-day period it had increased to from 95 to 98 per cent. The dead hoppers averaged from 135 dead to a square yard in the pasture and stubble, to 51 to the square yard in the tobacco. Practically no live hoppers could be found.

It was also noticed that whenever an application was made on a hazy or cloudy morning, which cleared either late in the morning or early afternoon, that a quick and highly efficient kill was obtained.

One very unusual result was noted in a successful control where a shower came on while the application was being made, and which was followed that night by a heavy rain. Ordinarily one would expect but a very slight kill under such conditions. At the end of two days not more than three or four dead hoppers could be found to a square yard anywhere in the treated area. At the end of five days conditions were practically the same. On the eleventh day the writer, in passing through the field, noticed that dead hoppers were much more abundant than when previously examined. A careful examination showed approximately 20 dead hoppers to the square yard over the entire treated area, which in this experiment covered about 60 acres. Compared to the original infestation, there were at least 85 per cent of the insects dead.

COMPARATIVE VALUE OF DIFFERENT ARSENICALS

Paris green was the popular poison in use at Janesville and consequently when poison bait was recommended or used as a control, Paris green was used. However, when the writer helped make an application he often used crude arsenious oxide, for at least part of the application. On some 34 control experiments Paris green was used 12 times, crude arsenious oxide 18 times, and calcium arsenate 4 times. Wherever crude arsenious oxide was used side by side in a direct comparison with Paris green, as was the case in six experiments, in which applica-

tions covered approximately 65 acres, very little choice could be found. Apparently both worked with nearly the same rapidity and were equally effective. The coarse grade of arsenious oxide was a little hard to handle, making a very careful mixing necessary. The lack of color also means that more care must be used to insure an evenly mixed bait. Calcium arsenate was used in four experiments in direct comparison with both of the above, and in all four gave good results. It was noted that it was not as rapid a poison as the others but the hoppers were made sick and apparently did no further injury. At the end of the five-day period, however, the mortality resulting from each of these three poisons was nearly the same. In treating tobacco, Paris green caused some leaf burn while calcium arsenate did not.

RATE OF APPLICATION

It was found in many cases, and especially so when there was any amount of vegetation in the field, that the use of the standard poison bait at the rate of 25 pounds for five to seven acres was not heavy enough to secure maximum results. This appeared to be due to the weakness of the odor of the standard bait. However, an addition of lemon extract to the standard formula made a much more odorous bait, and proved effective at the usual rate of application, while the standard bait when used at the rate of from six to eight pounds to the acre, gave efficient results. The use of lemon extract alone depends greatly upon the strength of the extract. One extract which was tried, and which did not give results, was found to be what was called a 2 per cent extract. Druggists' extracts were found to be at least a 5 per cent extract, and will run as high as 10 per cent.

It appears that the rate of application should depend upon the infestation and the attractiveness of the bait.

THE VALUE OF CRUDE ARSENIOUS OXIDE IN POISON BAIT FOR CUTWORMS AND GRASSHOPPERS¹

By JOHN J. DAVIS, *West LaFayette, Indiana*

Last winter (January, 1918) Mr. W. R. Walton submitted samples of a finely powdered crude arsenious oxide from a Montana copper smelter company to determine its effectiveness against cutworms and grasshoppers when used in bran bait as a substitute for Paris green. It was tested indoors with army worms (*Cirphis unipuncta*) and the results

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which warranted further tests in the field were published recently in the *Canadian Entomologist*.¹

The past spring a barrel of crude arsenious oxide was obtained from the same Montana smelter and samples were sent to entomologists in various parts of the country for testing. Unfortunately, the material was of a coarser and more granular grade than desired but the mistake was found too late to obtain another supply.

Most of those receiving a supply have furnished us with a summary of their results and they are briefly as follows:

C. N. Ainslie, Sioux City, Iowa. Did not have an opportunity to test material. However, he states that farmers of western South Dakota used car loads of arsenic obtained from the Montana smelters and with good results against grasshoppers.

G. G. Ainslie, Knoxville, Tennessee. Did not have an opportunity to test material.

C. W. Creel, Forest Grove, Oregon. Did not have an opportunity to test material.

S. E. Crumb, Clarksville, Tennessee. Did not test in field but results in laboratory experiments with cutworms gave the following results:

	Coarse	Crude Arsenious Oxide,	1-96	15	%	dead	5th	day	1	test
"	"	"	"	1-48	49	%	"	"	Av.	5 tests
"	"	"	"	1-24	79+	%	"	"	"	4 "
Powdered	"	"	"	1-72	87+	%	"	"	"	2 "
"	"	"	"	1-48	97-	%	"	"	"	3 "
"	"	"	"	1-24	97-	%	"	"	"	3 "
Paris green	"	"	"	1-96	95	%	"	"	"	5 "

Mr. Crumb concludes that the powdered grade will prove satisfactory against cutworms in the field at 1 to 50 pounds of bran and that a dosage of 1-25 can certainly be safely recommended.

Geo. A. Dean, Manhattan, Kansas, found the crude arsenious oxide furnished not quite as efficient as other poisons when used against grasshoppers but believes this due to coarseness and that if ground as fine as white arsenic or Paris green it would be an excellent substitute and equally as good.

W. P. Flint, Springfield, Illinois. Mr. Flint writes: "I used the crude arsenious oxide as a grasshopper poison, using it at one half the amount of Paris green and applied it in the same manner, with bran, fruit, and syrup, with practically the same results in the two fields where tested. E. M. Schalek tried it in the northern part of the state and he reports as good results or a little better than Paris green. I had some trouble because of coarseness of material, it sometimes taking an hour or an hour and a half for the lumps to dissolve."

¹Davis, J. J., and Turner, C. F. Experiments with cutworm baits. In *Canadian Entomologist*, vol. 50, No. 6, June, 1918, pp. 187-192.

L. G. Gentner, Madison, Wisconsin. Did not have an opportunity to test material.

Arthur Gibson, Ottawa, Canada. Only preliminary cage tests made which do not warrant definite conclusions.

J. R. Horton, Wichita, Kansas. Mr. Horton used the crude arsenious oxide in bait against mature grasshoppers in a wheat field, the first application being made October 7, using at the rate of seven pounds bait per acre. The regulation formula of bran, poison, molasses and lemon fruits was used, the poison and bran at the rate of 1 to 25. This application killed 74 per cent of the grasshoppers. A second application on the same area October 15, with bait prepared and applied as the first, gave 88 per cent killed, calculating the number of grasshoppers alive after the first poisoning as 100 per cent. The percentage killed by both poisonings was 96.9 per cent and Mr. Horton adds, "almost the only hoppers to be found were dead."

Philip Luginbill, Columbia, South Carolina. Did not have an opportunity to test the material.

G. I. Reeves, Salt Lake, Utah. According to Mr. Reeves the farmers of Utah use arsenious oxide, obtained from the nearby smelters, quite extensively in making poison bran mash.

D. A. Ricker, Janesville, Wisconsin. In his field tests with poison baits against grasshoppers, Mr. Ricker made comparative tests with Paris green, calcium arsenate and the crude arsenious oxide. He reports that he found little choice between Paris green and the crude arsenic as far as effectiveness and rapidity of killing was concerned. Calcium arsenate seemed effective but was a slower acting poison.

W. B. Turner, Hagerstown, Maryland. Did not have an opportunity to test the material.

T. D. Urbahns, Berkeley, California. For grasshoppers, Mr. Urbahns found Paris green and crude arsenious oxide about equally effective. He adds, however, that "the crude arsenious oxide was found more difficult to mix on account of settling to the bottom in the liquid" and that the same difficulty is more or less true with white arsenic.

R. A. Vickery, San Antonio, Texas. Did not have an opportunity to test the material.

R. L. Webster, Ames, Iowa. The sample was tested by C. A. Burge, County Agricultural Agent at Greenfield, Iowa, who reported to Mr. Webster under date of October 9, 1918, as follows: "In regard to the poison for grasshoppers made with crude arsenious oxide which was used at the farm of H. P. Proctor in this county, Mr. Proctor informed me yesterday that he obtained only fair results. Mr. Proctor thought if the arsenic could be soaked over night in water so as to dissolve the granules the results obtained might be better."

Don B. Whelan, East Lansing, Michigan. Mr. Whelan reports crude arsenious oxide to be as effective against grasshoppers as Paris green when used at the same strength, the formula used being one pound of poison, one bushel of sawdust, one scant pound of salt and one cup of molasses with water as needed. Mr. E. E. Twinge, County Agricultural Agent of Kalkaska County, Michigan, used a barrel of this crude arsenious oxide (coarse, granular grade) and obtained results generally favorable as to its efficiency against grasshoppers but he does not believe it gives as good satisfaction as white arsenic, of which several tons were used in Kalkaska County. This may have been due to the coarseness of the crude arsenic. The formula given by Whelan and noted above was used.

V. L. Wildermuth, Tempe, Arizona. Under date of October 18, 1918, Mr. Wildermuth writes, "We tried the crude arsenious oxide against grasshoppers on three different occasions and were not at all satisfied with the results." He adds that the earlier sample furnished by Mr. Walton, which was a finely powdered material, proved quite satisfactory and gave excellent results and concludes that a powdered grade would be quite more desirable than Paris green, chiefly because of its cheapness and equal effectiveness.

Our own experience with crude arsenious oxide has shown it to be quite satisfactory against cutworms, army worms, and grasshoppers, and in some cases it seemed to be even more effective than Paris green but when using the coarse, granular grade we experienced the same difficulty noted by others. We also found the bait almost as effective when half sawdust was substituted for bran.

From the above work conducted in various parts of the continent we conclude that crude arsenious oxide is a satisfactory and reliable substitute for Paris green at about one seventh the cost but that a powdered grade only should be recommended. The one advantage of Paris green over powdered arsenious oxide is its color which simplifies the mixing and makes possible an unquestionable thorough mixture.

SOME NOTES ON PHORBIA FUSCICEPS AS A BEAN PEST

By I. M. HAWLEY¹

In the spring of 1917 the bean crop in New York State was seriously damaged by the seed-corn maggot (*Phorbia fusciceps* Zett). In five townships of one county there was a loss of \$15,000 for seed destroyed by the insect, and in another county the loss on 16,000 acres planted was estimated to be between 50 and 75 per cent.

¹ Contribution from the Entomological Laboratory of Cornell University.

The damage is caused by the maggots in the ground when the beans are planted. As the bean swells on sprouting, the larvæ eat off the plumule or tunnel in the fleshy cotyledons. The beans often develop into stunted plants, known as snake heads, (Pl. 9), which do not mature and produce pods. If the cotyledons are above ground before the maggots find the plant, the stem beneath the ground is attacked. After eating its way to the pithy center the larva mines upward an inch or more.

There are two broods of flies each year in western New York and the writer believes that in some years there is a small third brood. The first flies emerged early in May in 1918 and there was a second brood during the last half of June and the first part of July. The time from egg to adult for bred specimens has varied between 25 and 47 days.

Flies emerging in May are attracted for feeding and oviposition to moist, freshly-plowed ground. The writer has found a few eggs on newly turned soil and obtained others by throwing pails of water on the ground around the laboratory. Several hours after the water was thrown out eggs were found in these moist spots, though none could be found in dry places. Eggs have also been found in large numbers around decaying bean vines as well as rotting cabbage and clover roots, and Prof. R. H. Pettit (in correspondence) reports breeding flies from fresh manure and decayed clover stems.

Many times in the literature reference has been made to decaying material as a breeding place for the maggots of *Phorbia fusciceps*. Schoene¹ reports finding the larvæ with those of *Phorbia brassicae* in cabbage-heads and when so found, they were in the decaying part of the plant. In examining bean fields, maggots have been found in healthy plants, although they are found in much larger numbers in beans which have begun to decay. As high as seventeen maggots have been found in one rotting bean.

If beans are planted when the ground is cold and wet, and the growth is slow and decay sets in, maggots will be attracted from their feeding places on buried clover roots or other decaying material to the beans in large numbers. This influence of cold rainy weather on the growth was demonstrated in the spring of 1917 when the rainfall at Rochester, N. Y., in the bean-growing section of the state was 6.40 inches from June 1 to July 1. Many growers lost their entire crop. In 1918 the rainfall for this same period was 2.40 inches and on the whole a fine stand of beans was obtained.

The writer had hoped to find some material which applied to the beans before planting would either repel the maggots or kill them as they fed on the cotyledons. However, anything placed on the seed-

¹ Journ. Econ. Ent. Vol. 9., p. 132.



1, Work of *Phorbia fusciceps* in beans soon after planting; 2, Stunted bean plants or "Snake heads"; 3, "Snake heads" sending out new leaves; 4, A plant developed from a "Snake head" compared to a healthy plant of the same age.

coat will be shed with it as the bean swells and the plant is again unprotected. At germination the bean is very sensitive to most insecticides and many things applied proved harmful to the growth. For these reasons and because it is usually impossible to predict an outbreak of maggots for experimental work, nothing of material value had developed up to the present time.

Professor Pettit as the result of work in Michigan believes that clover or alfalfa sod, fertilized with fresh manure and turned under just before planting to beans, makes the most favorable condition for serious injury, and advises the use of old manure or other fertilizer and that the ground be allowed to lie idle for awhile before planting. As the common rotation in western New York is to follow clover with beans and wheat, clover roots are often present for maggots to work on before entering the beans. If, as seems to be the case, eggs are laid at plowing or fitting time, and the ground is left fallow for about two weeks until the maggots present have pupated, beans may then be planted with safety. If the first seeding is destroyed, it is wise to delay replanting for a week or two until the maggots have pupated. In late seasons this may be impossible, and in that case it is better to substitute some other crop. Buckwheat is often used for this purpose in New York. Plowing the preceding fall or early in the spring before most of the flies appear should also tend to cut down the infestation.

In 1917 it was often observed that shallow planted beans were less damaged than those planted deeper. One grower started planting with a bean planter which placed the seed just beneath the surface of the ground, and then fearing that he was not putting them in deep enough he used a grain drill which buried the beans to a depth of three or four inches. At harvest time he had a good stand on the part where the planter was used, but the rest of his field was a total loss. The bean planter is now coming into greater favor because it is lighter and does not sink in so far in wet spots and so it is more easy to regulate the planting depth. Many growers are now putting the beans in so shallow that a boy is sent along to cover those left on the surface.

If a bean gets above the ground quickly, the chance of escaping the attack of *Phorbia fusciceps* is much better. Shallow planting, a judicious use of a quick acting fertilizer with an excess of seed will tend to increase the yield in wet seasons. Drilling beans deep in wet soil will surely result in a loss.

NOTES ON SOME LITTLE KNOWN PESTS OF RED-CLOVER

By GLENN W. HERRICK and J. D. DETWILER

During the past few years, a more or less continuous study of the insect pests of red clover has been carried on at Ithaca. Interruptions have occurred from time to time but a special effort was made last season by the writers to continue the investigation. It seemed that a study of clover insects in New York was of special significance in time of war. Clover is the principal crop in the northern states for the maintenance of the fertility of the soil and upon it, in great measure, depends the production of farm crops in a continuously average amount. Therefore any measure that will conserve clover and especially clover seed is of direct aid in a food crisis of this country. With this thought in mind the writers made special effort during the past summer to investigate the life-histories and injuries of three little known pests of red clover that occur abundantly in the vicinity of Ithaca. These are the lesser clover-leaf weevil, *Phytonomus nigrirostris*, the clover-head weevil, *Phytonomus meles*, and the clover tychius, *Tychius picirostris*.

The infestation of the first two species could hardly be considered severe as counts of infested and uninfested heads show. On June 29 a count was made of a total of 400 heads. Of these 6 per cent of the ripened heads, 1.8 per cent of those in bloom, while 7+ per cent of the immature heads were found infested. On July 1 another lot of heads, a total of 340, gathered near the border of a clover plot were examined for the presence of the weevil. Of these 21 per cent of the mature heads, 4 per cent of those in bloom, and 2.2 per cent of the green ones were found infested. In this case the percentage of infestation in the mature heads was highest. Again on July 2 a count of 403 heads was made. Of these 7 per cent of the ripened heads, 3 per cent of those in bloom, and 2 per cent of the green heads were infested. Here also the highest infestation was among the matured heads.

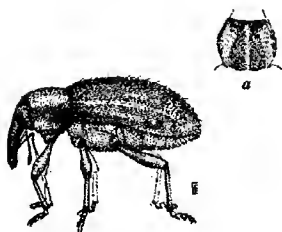


Fig. 8. *Phytonomus nigrirostris*; a, Thorax.

THE LESSER CLOVER-LEAF WEEVIL,
Phytonomus nigrirostris Fab.

This weevil (Fig. 8) was found in considerable abundance in clover fields at Ithaca. The larvæ were at work in immature heads, in those in bloom, and in those that had ripened. During the last days of June when this investigation began, larvæ and pupæ, and empty co-

cocoons were present in the heads of clover, the empty cocoons showing that some beetles had already emerged.

Those larvæ that live in the heads of the clover tunnel into the head and eat into the florets a short distance up from the bases and apparently devour the ovaries, thus preventing the development of seed. It is seldom that more than one larva is found in a head but this one destroys several florets. The larvæ of this beetle also work in the axils of the clover stems. In one small plot of clover the larvæ were quite numerous in the axils of the stems and committing considerable injury. The larva eats into the sheath surrounding the bud in the axil, severs the bud from the stem, and eats out a groove in the side of the main stem. Further investigations are necessary to determine the amount and seriousness of this injury.

During the latter part of June and the first part of July the larvæ became full grown. Many of them had already spun cocoons by June 29 and from some cocoons the beetles had emerged. The lacelike cocoons are found in the heads of the clover, often at the base of the head. The following table contains data on the length of the pupal stage:

DURATION OF PERIOD IN COCOON		
Date of Spinning Cocoon	Emergence of Beetle	Period in Cocoon, Days
June 27	July 13	16
June 29	July 13	14
July 6	July 19	13
July 12	July 25	13

On June 28 a number of larvæ were placed in a cage with clover. On July 2 one cocoon was found and by July 4, eight had spun cocoons. The first beetle emerged July 16, another July 17, and a third July 18. From the foregoing data it is apparent that the time spent in the cocoon varies from 13 to 16 days, probably varying with the individual and the temperature.

THE CLOVER-HEAD WEEVIL, *Phytonomus meles* Fab.

This is a foreign weevil that has apparently been recently introduced into this country, probably from Europe. It is said to occur widely over Europe and is also found in parts of Asia and along the north coast of Africa. In this country it has been found in New Hampshire, Massachusetts, Connecticut, New Jersey, and New York. Apparently it was first noted in New York in 1907. During the past season this weevil was abundant in red clover fields in the vicinity of Ithaca and was evidently contributing to the general insect injury to this plant.

The beetle is from one seventh to one fifth of an inch in length and, in general, of a grayish or greenish-brown color. The specimens reared

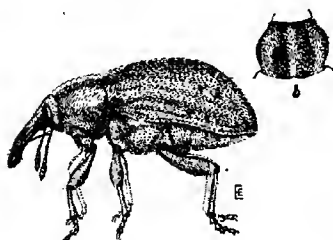


Fig. 9. *Phytonomus meles*; b, Thorax.

by us are distinctly striped with longitudinal lines of light brown scales near the lateral edges of the elytra. The thorax has two wide, dark longitudinal dorsal stripes separated on the median line by a narrow golden-brown stripe (Fig. 9). The thorax is wider than long and markedly rounded on each side while

the thorax of *P. nigrirostris* is longer than wide and less rounded on the sides (Fig. 8, a).

Our studies began too late in the season to find the eggs but Titus has found them deposited on and in the stems, and leaf petioles of clover and alfalfa and on blossoms of clover. The larvæ were present in abundance however in the heads of clover. The larvæ probably spin their cocoons in the field on the heads of clover, often between the bracts on the head and probably also in the axils of the branches. All of the cocoons observed were formed in the laboratory under abnormal conditions but their positions indicate that they would be placed in the field as suggested. The pupæ are interesting from their conspicuous and active movements in their cocoons. In one instance a pupa was formed which had not been able for some reason to spin its cocoon. The violent and rapid movements of this pupa when disturbed seemed quite remarkable. Moreover, the same movements of the pupæ within the cocoons were repeatedly noted. The following table presents data on the length of the cocoon stage:

DURATION OF PERIOD IN COCOON

Date of Spinning Cocoon	Emergence of Beetle	Period in Cocoon, Days
July 2	July 21	19
July 2	July 18	16
July 4	July 18	14
July 5	July 19	14
July 6	July 19	13
July 10	July 23	13
July 10	July 22	12

It will be seen from the foregoing table that the time spent in the cocoon varies from 12 to 19 days, the period apparently growing shorter with the advancing season.

THE CLOVER TYCHIUS, *Tychius picirostris* Fab.

The clover Tychius is a small grayish snout-beetle only about one tenth of an inch in length. It is known in Europe, according to Blatchley and Leng, as *Miccotrogus picirostris*, and there it lives in the capsules of red clover, and on plantain and *Genista*. The beetle is certainly widely distributed in New York State. Knight has found it abundant especially on pear trees and Casey reports it "in extraordinary numbers at Lake Champlain." Felt reports it from Waterville, New Baltimore, Albany, Newport, Speculator, Gouverneur, Oswego and McLean. Outside of New York it has been taken in Maine, New Hampshire and Massachusetts. In Canada, Du Porte records it in large numbers in nearly all fields of common red and mammoth red clover in the vicinity of Ste. Anne's, Quebec. Here the adults were feeding gregariously on the leaves while later in the season they attacked the flower heads of clover.



Fig. 10. *Tychius picirostris*.

Here at Ithaca we find it abundantly in fields of red clover. As many as nineteen adults were found in a newly opening head of red clover. The beetles apparently feed upon the pollen of the florets. In a count made 90 per cent of the florets were punctured and in most of these the anthers were shrunk and discolored.

The larvæ are white and only about 2 mm. in length and are found living in the clover heads where they apparently feed upon the florets. They were found in abundance during July and through the month of August. The insect is undoubtedly capable of doing considerable damage. When the larvæ are full-grown they go into the soil and there form cells apparently by cementing grains of soil and sand firmly together. The summer brood of beetles began appearing about the middle of August. We can say nothing yet as to the mode of passing the winter or as to the eggs or place of deposition. It is hoped that the investigations may be continued during the coming season.

The writers wish to make acknowledgement to Miss Ellen Edmonson for the drawings of the three species considered.

European Corn Borer. A subcommittee on the pest has been appointed by the Chairman of the Committee on Policy of the American Association of Economic Entomologists. It consists of E. P. Felt, Chairman and Messrs. Herbert Osborn and J. G. Sanders and is charged with all phases of the problem which might properly come within the province of representatives of a national organization.

THE DISPERSION OF FLIES BY FLIGHT¹By F. C. BISHOPP and E. W. LAAKE, *U. S. Bureau of Entomology*

ABSTRACT

Up to very recent years it has been generally held by entomologists that flies are comparatively limited in the distances which they will go from breeding places. Dr. Parker's work in Montana indicated that the house-fly is normally migratory in habit and he succeeded in obtaining specimens nearly two miles from the point of liberation. In 1916 the authors conducted some preliminary experiments in which colored flies were liberated in the vicinity of packing houses and a considerable number of these were recovered quite promptly in traps placed in the yard of the packing establishments, a flight of about three-fifths of a mile. The flies liberated in this experiment consisted largely of blow-flies of the species *Chrysomya macellaria* and *Phormia regina*. Later in the same summer a series of experiments was carried out to determine the distance of flight of several species of blowflies and house-flies under rural conditions. The flies were liberated at a point near the intersection of two roads and four traps were placed at given distances in the four cardinal directions from the point of liberation. A total of 1,745 colored flies were recovered in the sixteen recovery traps and a considerable number of these were in the outer ring of traps which was approximately three miles from the point of release. Another experiment was conducted immediately following this in which the traps were moved outward in the four directions to points approximately 2, 3, 4 and 5 miles from the point of liberation. House-flies, screw-worm flies and the Anthomyid, *Ophyra leucostoma*, were recovered in some of the most distant traps.

In 1918 it was determined to make more extensive tests of the dispersion tendencies of various species of flies. The same general plan was followed as in the previous experiment, four traps being set in each of the cardinal directions from the point of liberation at distances approximately $4\frac{1}{2}$, 6, 7 and 8 miles. About 60,000 colored flies were liberated, approximately 58 per cent being screw-worm flies, 39 per cent house-flies and the remainder *Phormia regina*, Sarcophagids and other species. As in previous experiments the flies in the various traps were killed daily and examined carefully for marked individuals. The day following liberation a considerable number of marked house-flies and screw-worm flies were recovered in several of the traps. Even in those located 8 miles in each direction from the point of release, some screw-worm flies were taken. Following this experiment the traps were removed

¹ Published by permission of the chief of the Bureau of Entomology.

to points east and west approximately 9½, 11, 13, 15 and 17 miles, two traps to the north 13 and 17 miles, and two traps to the south 8 and 10 miles from point of release. A trap was also placed about 7 miles east of south and another about 10 miles south of west of the point of liberation. About 80,000 flies were released in this test. The greatest distance from the point of liberation at which marked flies were recovered was: House-flies, 13 miles; screw-worm flies, 15 miles; *Phormia regina*, 11 miles and *Ophyra leucostoma*, 7 miles.

It is believed that the following of vehicles by flies in these experiments was unimportant. In general the experiments suggested that there is a natural tendency toward dispersion exhibited by both sexes of all species used in the tests. Many apparently favorable feeding and breeding places were passed in the course of migration. The relationship between direction of travel and the direction of the wind appeared not to be very close.

The many practical bearings of the question of distance and rapidity of travel of flies cannot be discussed here, but are apparent to all.

It might be pointed out that this is the first series of experiments in which flight studies have been made with flies other than *Musca domestica*.

NOTES ON PHLEBOTOMUS SPECIES ATTACKING MAN¹

By D. C. PARMAN, *Bureau of Entomology, United States Department of Agriculture*

Observations have been made on *Phlebotomus* sp.² attacking human beings at Uvalde, Texas, during the months of September, October and November since 1915. The writer has been located at Uvalde since October, 1913, but the species was not observed until the fall of 1915. It is quite possible that the insect was present before that season and may be native in the region, but the people generally spoke of it as "the new mosquito or bug that bites so hard." Considerable complaint was received during the fall of 1915 from residents of the higher parts of the town. My first experience with the bite was during the latter part of October. I was at a table under an electric light and was bitten on the face by what was evidently a *Phlebotomus*. Specimens were taken later and so identified.

Heretofore no records of the occurrence of *Phlebotomus* in the Southwest have been made and there are no published statements regarding the attack upon man by *Phlebotomus vexator* Coq., the only species of this genus known to occur in the United States. The occurrence of

¹ Published with the permission of the chief of the Bureau of Entomology.

² A determination of the species concerned has not been secured.

Phlebotomus in the Southwest and the fact that they appear to attack man freely deserves some attention, owing to the fact that this group of insects is known to carry papataci or three-day fever in the Mediterranean region, and evidence also points to its acting as vector of verruga in the Peruvian Andes.

During the fall of 1916 the infestation was heavier than the previous season and the appearance was about a month earlier; in 1917 the infestation was lighter but was present at about the same dates, the latter part of August until November. The early heavy freezes during the fall of this year caused an earlier disappearance. In 1918 the insect appeared the first part of September and disappeared in the latter part of November. The earliest authentic record of appearance is September 3, 1916; the latest record is November 24, 1915. During 1916, 1917 and 1918, the species was present in greatest numbers from September 25 to October 10. The adults always disappear with the occurrence of freezing weather. The abundance is extremely variable and amounts to from only one specimen attacking in several nights, to as many as twenty-five or thirty attacking each night for a short period during the height of the infestation. Rarely more than four specimens have been observed on a person at one time, and the greatest number was seven.

The bite is very painful and the sensation will last as long as one minute or more. There is no warning of the approach or attack and one is not aware of the presence of the insects until they are well seated. They are not easily disturbed after they begin to feed and are generally easily captured. I have allowed them to feed from ten to sixty seconds on my arm and none have ever appeared to complete a meal. The after effects of the bite last from twelve hours to as long as two or three days. On some persons there is no swelling, but a slight reddening of the area surrounding the point of attack; on others the swelling is considerable, the raised place being about two inches in diameter and nearly one-fourth inch high and is always attended by itching which continues for some time after the swelling leaves.

The insect is quite active at night but not nearly so evasive as the mosquito, the flight being more deliberate. When disturbed during the day flight is sluggish and irrational. The insects are found hiding in dark places during the day only, one or two specimens at a place. They have never been observed to venture out of hiding until well after sundown and the attack has never been observed earlier than eight o'clock or about one hour after sundown. They have been observed to be most numerous at lights on dark nights, but have been known to attack in late twilight but not in the dark or moonlight.

No data as to the breeding habits have been collected, but there is

some evidence that the breeding places are in neglected poultry houses. They have been observed to be quite abundant around such places during the late twilight hours. Observations have been made to note if they attack poultry, but all have been negative.

Aside from the annoyance of the bite of the *Phlebotomus* it is quite probable that it is a carrier of disease. There is some evidence of a circumstantial nature that is incriminating. During the fall of 1916 there was an outbreak of a mild form of what was termed by the local physicians dengue fever, the latter part of September and in early October. The outbreak was practically an epidemic. The disease occurred in 1917 with a smaller number of cases. In 1918 there were many cases of Spanish influenza and the local physicians are uncertain as to whether any cases of the so-called dengue appeared. The fever lasts about three days and runs about 102°F. to 103°F. There appears to be a tendency toward a recurrence of the fever each year in some cases.

GRASSHOPPER CONTROL IN KANSAS¹

By GEORGE A. DEAN, *Entomologist, Kansas State Experiment Station*, E. G. KELLY, *Extension Entomologist, Kansas State Agricultural College*, A. L. FORD, *Special Agent, U. S. Bureau of Entomology*

During the summer and fall of 1918, the grasshopper outbreak in Kansas was one of the worst in the history of the state. The outbreak did not come without warning, for in the previous year, in several localities in western Kansas, the grasshoppers were present in such damaging numbers that control measures had to be practiced in order to save the crops. It was evident that should the eggs be deposited in large numbers, and should the weather prove favorable for most of the egg capsules to pass the winter uninjured, the season of 1918 would be one of the most serious grasshopper years that the state had experienced. In the fall, the Department of Entomology and Extension Division of the Kansas State Agricultural College, in coöperation with the Federal Bureau of Entomology, placed an agent² in

¹ Contribution from the Entomological Laboratory of the Kansas State Agricultural College, No. 37.

² Mr. Scott Johnson, special field agent of the Federal Bureau of Entomology, did the survey work in the fall of 1917, and assisted with the extension work during the winter and early spring of 1918, at which time he entered the navy. Because of the urgent need of continuing the work, Mr. A. L. Ford, scientific assistant, Bureau of Entomology, on request, was transferred from the investigational work to the extension service. Much of the success in organizing the farmers to poison the grasshoppers and to disk to destroy the eggs was due to Mr. Ford's excellent work in the field.

western Kansas to make a grasshopper egg survey. Throughout the western part of the state the eggs were found in large numbers. In the spring following the dry cold winter, another survey was made and it was found that a high percentage of the eggs had come through the winter unharmed, and thus it was almost certain that in order to protect the crops a campaign on grasshopper control would have to be conducted.

It was decided to conduct the campaign by holding demonstration meetings, personal farm visits with demonstrations, and by appropriate window displays throughout the counties where prospects for grasshopper outbreaks were favorable. This work was started in the field on May 13, which was about the normal hatching time of *Melanoplus differentialis* and *M. bivittatus*. During the next seven weeks, 21 counties were covered, in which 24 demonstrations were given, 16 window displays arranged, and 240 farmers visited on their farms and given instructions. At each demonstration the life-history of the grasshopper was explained and a small amount of poison bran mash was properly mixed and distributed with a sowing device.¹ In this way the farmers could actually see the process and should make no mistake in mixing large hatches for use on their farms. Not only was much interest shown at these demonstrations, but the proposition actually was put into practice by a great number of farmers.

In three counties, Finney, Hamilton, and Kearney, the ingredients for the poison bran mash were provided for out of county funds, and was distributed in the fields following the first cutting of alfalfa. In practically every instance where the poison was used the second crop of alfalfa came on normally. However, many farmers did not use the poison, and almost without exception they cut but one short crop of

¹ Device described by T. H. Parks, Journ. of Econ. Ent., Vol. 10, No. 6, pp. 524-525, 1917.

EXPLANATION OF PLATE 10

1. Demonstration meeting at Olmitz, Kans., attendance 127. The wheat to the left of the road completely destroyed from 15-20 rods back from the road. Egg pods very numerous along the roadside.
 2. Demonstration meeting at Offerle, Kans., attendance 70. Wheat to the right of the road destroyed. The grass land between the wagon road and the railroad contained a large number of egg pods.
 3. Demonstration meeting on a Ford county farm, attendance 10. Picture shows an uncultivated strip of land with wheat on either side. A typical place for oviposition. Egg pods were very abundant.
 4. Demonstration meeting at Heizer, Kan., attendance 23. A hard beaten fence-row between two wheat fields. A typical place for oviposition. Egg pods were very numerous. Both wheat fields badly injured.
- All photographed by A. L. Ford.



alfalfa during the entire season. In several other counties the farmers purchased their own poison, and saved their alfalfa.

During the latter part of June, a large amount of poison bran mash was used in the sugar beet district of the state, and excellent results were had in protecting the sugar beets. Later in the summer the farmers of Thomas County organized, distributed the poison bran mash, which was provided by the county, and protected their alfalfa, and forage crops.

Throughout the earlier part of the summer a close watch was kept on the hopper situation. In western Kansas the small egg capsules of the late hatching *Melanoplus atlantis* were present everywhere in the hard soil in large numbers, and it was then evident that the farmers would have trouble with this pest on their wheat in the fall. Early in September reports began to come to the effect that the small lesser-migratory hopper was doing serious damage to the early fall planted wheat throughout the western part of the state, and thus a second campaign for demonstrations on grasshopper poisoning was arranged. A survey of the situation not only revealed the grasshopper present in dangerous numbers, but also that large numbers of eggs were already deposited in the soil in places accessible to the disk. Since the time for poisoning *M. atlantis* was in the early fall, and since this was also the proper time to emphasize the importance of destroying eggs, it was decided to combine both poisoning and fall disking to destroy the eggs in these demonstrations. This campaign proved to be a complete success. The attendance at the demonstrations was large, and unusual interest was shown by the farmers, especially in the fall disking demonstrations.

In this campaign in western Kansas, 12 counties were covered in which 59 demonstrations were given with a total attendance of 1,273 farmers, or an average of 22 at each demonstration.¹ At these meetings a short explanation was given of the life-history of the grasshopper, with special emphasis on the oviposition habits. The proper method of mixing and applying the poison bran mash was explained and demonstrated. Following the discussions on poisoning, the fall disking proposition was taken up in the following manner: The crowd was conducted to a nearby roadside or fence row where grasshopper eggs were abundant. Grasshopper oviposition was reexplained, with special emphasis on the place of oviposition. (There nearly always is found a very large number of eggs in the hard grassy places at the edge of cultivated fields. The reason for this is that in the fall the majority

¹ Had it not been for the state ban on all public meetings on account of the influenza epidemic, much more could have been accomplished. Practically all the scheduled demonstrations after October 16 were cancelled.

of hoppers are found feeding on the most succulent food which is usually in cultivated land. Since they do not oviposit in loose cultivated soil, they migrate to hard ground and they usually stop at the first favorable place, and thus the egg capsules are very numerous along the edge of the cultivated fields.) The egg capsules were dug up and passed around, the number of eggs in several pods were counted and the number of pods to each spadeful of earth was determined. In this way it was impressed on the farmers just how many eggs an uncultivated roadside or fence row could harbor. It was interesting to notice that although these farmers had been fighting grasshoppers for years, very few of them had ever seen or noticed one of the egg pods before.

After the farmers were convinced of the places of grasshopper oviposition, and of the overwhelming abundance of the eggs, a piece of roadside or fence-row was then actually disked, and they were shown just how the egg capsules were torn up and exposed by this process. In every case it was no trouble to find eggs torn from the pods and scattered broadcast behind the disk, and in every case the farmers were fully convinced that fall disking of the hard grass places adjacent to cultivated fields was a very important factor in solving the grasshopper problem in Kansas.

At each meeting coöperation was emphasized as much as possible, and in many cases whole townships actually organized at the meetings to do the disking later as a unit. A grasshopper-egg disking day was set aside, at which time all farmers in a community arranged to disk their fence-rows, irrigation ditch banks and roadsides.

In checking up the results of the various campaigns against grasshoppers in Kansas in 1918, we find that eight counties, Thomas, Sheridan, Ford, Finney, Kearney, Hamilton, Meade, and Seward, furnished white arsenic to their farmers and, with the exception of Finney County, the rest of the ingredients for making the poison bran mash.¹ In these eight counties, 35,500 pounds of white arsenic, 355 tons of bran and sufficient syrup and lemons to go with this amount of arsenic and bran were put out as county projects. Even this large amount was not sufficient to go around and many of the farmers in these counties bought their own materials.

Questionnaires were sent out to a large number of local druggists throughout the western part of the state to determine the general run of white arsenic and Paris green sales as compared with previous years. It was found that this representative group of local druggists sold

¹Two other counties organized for the purpose of furnishing materials to their farmers, but found the supply of arsenic exhausted.

more than twice as much white arsenic and Paris green than they did the previous year.

The results of the grasshopper poisoning were excellent throughout the state. Very few reports of poor results were received, and in practically every case these were due to improper methods in mixing and applying. Very few cases of poultry or stock poisoning were reported, and without exception all such cases were due to carelessness on the part of the farmer. In every county where poisoning was done extensively, the farmers were more than pleased with their results. Thousands of acres of alfalfa, wheat and other crops were actually saved from the ravages of the grasshoppers.

As a result of the fall disking demonstration, seven counties organized to disk fence-rows, roadsides, and other hard grassy places adjacent to cultivated land.

A USE OF GALLS BY THE CHIPPEWA INDIANS

By WILLIAM A. RILEY, *University of Minnesota*

In a recent paper,¹ Margaret M. Fagan has presented a valuable summary of an extensive study of the literature dealing with the uses of insect galls. In the course of her discussion she says, "So far as can be ascertained no American galls were ever used for any practical purposes by the Indian (statement of Dr. Hough, United States National Museum), and but few by the white man."

In view of this statement it is worthy of record that a gall on the sumach, *Rhus glabra*, is used medicinally by the Chippewa Indians in Minnesota.

This gall is produced by an undetermined mite, referred to in the literature as a species of *Eriophyes*. It has been well figured by Thompson, 1915 (pl. 19, fig. 97), as "*Eriophyes*, or fungus on *Rhus copallina*," and by Felt, 1918 (text-fig. 164, and pl. 16, fig. 7). It occurs very commonly on *Rhus glabra* in Minnesota, causing characteristically stunted heads and curled leaves. These deformed heads are collected by the medicine men in late summer, and used in the form of an infusion as a remedy for diarrhoea. I am told that they are also used in the preparation of a poultice for the treatment of burns, but could learn no further details.

It is well known that owing to the quantity of tannin which they contain, galls are powerfully astringent. The earlier editions of the

¹ American Naturalist, 1918, LII, 155-176.

United States Dispensatory spoke of them as occasionally employed in cases of chronic diarrhoea. The last (20th, 1918) edition contains the somewhat contradictory statement that they "are no longer prescribed internally. Aromatic syrup of galls is sometimes prescribed." This syrup is a form in which they were employed in the treatment of diarrhoea.

Official galls are derived almost exclusively from *Quercus infectoria*, and this is recognized as their source in the United States Pharmacopœia. They are produced by *Cynips gallatinctoriæ* Olivier, and are of the well-known hard, spherical type, about ten to twenty millimeters in diameter. They are often known in commerce as the Aleppo galls, since they formerly were largely produced in the vicinity of the Syrian city of that name.

The most significant feature of the use of galls by the Indians for the same disease as that for which the official preparations were more often used, is that the Indians use a type of gall differing radically from that above described. Doubtless both owe their efficacy to the presence of tannin but it is clear that the Indian usage could not be a modern one, derived from that by the whites.

Scientific Notes

Hessian Fly: Supplementing previous outdoor experiments, to determine whether or not certain strains of wheat are actually less severely attacked by the Hessian fly than others, the Department of Entomology of the Missouri Agricultural Experiment Station is carrying through an interesting series of greenhouse experiments. Some difficulty has been experienced in making growing conditions absolutely uniform, where a large series of varieties are tested and the conditions under glass are naturally not exactly the same as in the field. Standard Missouri varieties as well as others previously reported as having resistant qualities are being used in the experiments. The pest seems to breed and develop normally indoors on all strains tested, but in the first test just completed, some varieties are decidedly less severely attacked than others. Chemical tests and observations on different structural variations of the indoor plants are also being made the same as in case of the field experiments.

LEONARD HASEMAN.

European Corn Borer in Connecticut: What appears to be a small infestation of the European Corn Borer, *Pyrausta nubilalis* Hubner, was found in Milford, Conn., March 12, by assistant entomologists from the Agricultural Experiment Station. The infestation lies just north of the village, and at this writing its limits have not been definitely ascertained. Prompt measures will be taken to suppress the pest.

W. E. BRITTON.

A Correction: In the JOURNAL OF ECONOMIC ENTOMOLOGY, Vol. 11, No. 5, p. 431, I made the statement that I had found the Cherry-Leaf-Beetle, *Galerucella canalicollis* LeC., feeding on several species of azalea. This azalea feeding beetle, I now find, on more carefully comparing the specimens, is *Galerucella rufosanguinea* Say. To my good friend, Dr. E. A. Schwarz, I am indebted for calling my attention to the matter.

Berkeley, Cal., March 3, 1919.

EDWIN C. VAN DYKE.

A New Root Maggot Treatment. The soils and climatic conditions of the Pacific Coast are such that most cruciferous crops thrive exceptionally well. Cabbage, cauliflower, turnips, radishes and the like are grown in most every garden and are standard market garden crops; thousand-headed kale is grown by almost every dairyman and poultryman; and the cabbage seed-growing industry of the United States is centered largely in Skagit County of the State of Washington. These crops are therefore very important in the agriculture of western Washington. All of these crops are infested more or less each year by the cabbage root maggot (*Phorbia brassicae* Bouche). The damage done by this pest makes it one of the most important insect pests which we have to combat.

Each season for many years past experiments looking toward the control of this pest have been carried on at the Western Washington Experiment Station. New treatments tried from year to year have so added to the "found wanting" list that it makes quite an impressive array of blighted hopes. Of the many treatments that have been tried, the tarred felt collar for transplanted crops such as cabbage, kale and cauliflower has been the most effective prior to this season.

The use of powdered borax to kill house-fly maggots in manure as recommended by the United States Department of Agriculture and the successful use of "green tar oil" in English army camps to prevent manure heaps from becoming a breeding place for house-flies suggested to the writer their use for root-maggot control. Accordingly, this past season these two materials were tried along with the usual number of new "remedies."

The recommended borax treatment to kill house-fly maggots in manure is 1 pound of powdered borax to 16 cubic feet of manure. Based on this recommendation $\frac{1}{2}$ pint of a solution in which 1 ounce of powdered borax is dissolved in 10 gallons of water should effectively treat 10 cubic inches of soil. This was assumed to be about the proper treatment for one plant. Solutions of 1 ounce of powdered borax to 2 $\frac{1}{2}$ gallons, 5 gallons, 10 gallons and 15 gallons of water were used at the rate of $\frac{1}{2}$ pint to the plant. The stronger concentrations had a slightly injurious effect on the kale plants, thousand-headed kale being used in these experiments. Some few plants were killed and others were noticeably stunted. These treatments showed practically the same percentage of loss as the checks, so are apparently of no value in the control of root maggot.

"Green tar oil" used at the rate of 1 part to 40 parts of soil, applied 1 inch thick on manure heaps, has been reported (W. H. Saunders in the 1916 *Proceedings of the London Zoological Society*) to effectively protect them from becoming a breeding place for house-flies. This oil is a heavy coal tar distillation product known in this country as anthracite or anthracene oil. It is insoluble in water and non-volatile. It was obtained from The Barret Company, New York, and The Republic Creosoting Company, Seattle. The latter company reports that anthracene oil will retail at approximately \$1 a gallon.

In our experiment with anthracene oil, soil from the field in which the transplanting was to be made was used as a carrier rather than anything else, because in that way

nothing other than the oil was introduced and because the mixture was easily made, simple and inexpensive. The anthracene-oil-treated soil was scattered around the base of the plant to form a protecting collar, 1 gallon of the mixture being used to about 200 plants. The rates used were 1 part of the oil to 20, 40 and 80 parts of soil by measure. It was hoped to establish the upper and lower limits of concentration that were effective and non-injurious. The 1 to 20 mixture proved injurious to the plants, as a number died as a result of the treatment. The results indicate that the 1 to 80 mixture may be stronger than necessary, as this treatment proved most effective. Distillate was used in one test to thin the oil to facilitate mixing. The treatments were applied as soon as the kale was transplanted. The results secured with these treatments follow:

KALE TRANSPLANTED JULY 6-10

Treatment	Number of Plants Treated	Final Count of Missing Plants	Per Cent of Loss
Untreated	185	86	46.5
Anthracene, 1-20	70	14 ¹	20
Anthracene, 1-40	80	10	12.5
Untreated	35	17	48.6
Anthracene, 1-80	125	13	10.4
Anthracene, 1-40 (Oil diluted with distillate)	61	12	19.8
Untreated	185	59	31.9
3 Untreated	305	162	40
4 Anthracene Treatments	336	49	14.6
Tarred Felt Collars	184	27	14.7

As only a small amount of anthracene oil is necessary in the mixture and soil is a satisfactory carrier, this treatment is cheap, readily prepared and easily applied. If it proves as effective in succeeding seasons as it did in our experimental plots this year it should come into general use

E. B. STOOKEY.

MEETING OF PACIFIC SLOPE BRANCH AMERICAN ASSOCIATION
OF ECONOMIC ENTOMOLOGISTS

The annual meeting of the Pacific Slope Branch will be held in connection with the State Fruit Growers' Convention, at the Citrus Experiment Station, Riverside, Cal., May 28 and 29.

This meeting has been set especially to accommodate the visiting Eastern and middle West entomologists, many of whom are to attend this convention. Regular announcements have been sent to all members living west of the Rocky Mountains. Earlier decisions to hold this meeting at Berkeley or Pasadena have been changed in favor of Riverside as stated above.

A cordial welcome is extended to all visiting entomologists. They will find the Citrus Experiment Station and the School of Subtropical Agriculture most interesting and inspiring. The meetings and discussions can not fail to interest entomologists.

E. O. ESSIG, *Secretary*.

H. J. QUAYLE, *Chairman*.

¹ Part of loss due to the effect of the treatment.

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OFFICIAL ORGAN AMERICAN ASSOCIATION OF ECONOMIC ENTOMOLOGISTS

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The editors will thankfully receive news items and other matter likely to be of interest to subscribers. Papers will be published, so far as possible, in the order of reception. All extended contributions, at least, should be in the hands of the editor the first of the month preceding publication. Contributors are requested to supply electrotypes for the larger illustrations so far as possible. Photoengravings may be obtained by authors at cost. The receipt of all papers will be acknowledged.—Ede.

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Our most important farm crop is threatened with very serious injury by a recently introduced insect. This pest has a bad record in Europe. It has demonstrated in this country its ability to cause very great losses when allowed to multiply unrestrictedly and its known distribution indicates an ability to maintain itself throughout our corn belt. Furthermore, studies conducted during the last two seasons in the infested area in Massachusetts have resulted in finding no really satisfactory method of control. This recent introduction appears to have become established in only a few relatively limited areas.

The European corn borer is unquestionably a serious menace to our enormous corn areas and to some related crops, particularly Kafir corn. Its natural spread appears to be slow, though evidence at hand indicates at least two and possibly more commercial jumps, which mean the establishment of the pest in centers remote from other infested areas and in some sections at least where natural agents of dissemination, such as flood waters, may prove a most important factor in carrying the insect into new territory. The situation is further complicated by the occurrence of the pest in badly infested areas in the stems or stalks of a variety of garden vegetables, a number of grasses and common weeds, the latter greatly increasing the difficulty of control or extermination.

The situation is a critical one. The insect is injurious, not easily controlled and the feasibility of extermination has yet to be demonstrated. Nevertheless, the spread of the insect through both natural and artificial agencies is continuing and very soon its dissemination

may be so general as to make eradication or extermination impractical. This is a problem which has been thrust upon American entomologists by conditions over which they have no control. It must be solved within a few months. The value of the crop threatened is so great and the interests affected so vital to our national welfare, that we feel that nothing short of a most energetic effort to meet the situation and avert, if physically possible, the probability of subsequent enormous annual losses can be justified in the future.

Review

Key to American Insect Galls, by EPHRAIM PORTER FELT, D. SC.
Bulletin 200 New York Museum, 310 pages, 16 plates, 250 figures,
Albany, N. Y., 1918.

Though several bulletins and many scattered papers have been published on American insect galls, none have the object or scope of Dr. Felt's work which brings together in one volume a tremendous amount of information in a form most convenient for the busy worker to use in identifying galls. In plan, the hosts are arranged according to the botanical relationship of the families, and under each family or genus is a workable key or table for separating the galls occurring on the plants of that division. A large proportion of the galls are illustrated by excellent line drawings or by photographs reproduced in half-tone on the plates. The descriptions, though brief, are sufficient, together with the illustrations for purposes of identification. The insects forming galls on each family or group of plants are given in tabular form near the end of the book. An excellent index combining both plant and insect names renders the volume convenient for ready reference. Though Dr. Felt has for many years been studying dipterous galls and has described many new species and published a number of papers, probably none of his work will be appreciated by entomologists and laymen as much as this successful attempt to bring together in one volume, all American gall insects and their hosts, with means of ready identification. (*Adv't.*)

W. E. B.

Current Notes

Conducted by the Associate Editor

Mr. Hugh Knight has been appointed assistant in entomology at the citrus sub-station at Riverside, Cal.

Miss Evelyn Osborn has accepted the position of assistant entomologist with the Florida Experiment Station.

Mr. C. C. Hamilton has been appointed extension instructor in entomology at Missouri University and Station.

Mr. A. T. Speare of the Bureau of Entomology recently received the degree of doctor of philosophy from Harvard University.

Mr. H. J. Reinhard has been promoted from assistant entomologist to entomologist, of the Texas Agricultural Experiment Station.

Mr. A. C. Baker of the Bureau of Entomology recently received the degree of doctor of philosophy from George Washington University.

Mr. C. A. Weigel, connected with the Federal Horticultural Board, has recently been released from military service and resumed his duties in Washington.

Seven field men were scouting Eastern Pennsylvania during March for the European corn borer, under the direction of Prof. J. G. Sanders, economic zoologist.

Mr. E. H. Siegler of the Bureau of Entomology gave an illustrated address before the Connecticut Pomological Society at Hartford, Conn., on January 24, 1919.

Mr. G. N. Wolcott, who has been in the service with the A. E. F. in France, has returned to Cornell University where he has begun work for his doctor's degree.

Lieut. F. H. Lathrop, assistant entomologist in the Oregon Experiment Station was released from military service early in the year and has returned to his duties in Oregon.

Captain R. D. Whitmarsh of the U. S. Army, formerly assistant entomologist of the Ohio Agricultural Experiment Station, has been assigned to duty at Houston, Texas.

Mr. J. M. Robinson, formerly in extension service in Tennessee, has entered upon work in the Department of Entomology in the Alabama Polytechnic Institution, Auburn, Ala.

Mr. J. B. Garrett, entomologist of Agricultural Experiment Station, Baton Rouge, La., is on an indefinite leave of absence, and the work is in charge of W. E. Anderson, acting entomologist.

Mr. Charles P. Alexander of Kansas State University has been appointed systematic entomologist and custodian of collections for the Illinois State Natural History Survey, Urbana, Ill.

Mr. M. L. Benn, field assistant on crop pests with the Bureau of Zoölogy of Pennsylvania, is taking special work at Cornell University this year, in entomology, plant pathology and horticulture.

Mr. Geo. G. Becker has been released from the Navy and has accepted a temporary appointment with the Bureau of Entomology to do extension work on deciduous fruit insects in the state of Arkansas.

Mr. W. E. Jackson has returned as assistant entomologist and chief apiary Inspector of the Texas Agricultural Experiment Station, after a year of service in the medical laboratory of the U. S. Army.

Mr. I. L. Ressler, recently discharged from the Chemical Warfare Service, has taken up his former work as instructor in the Zoölogy and Entomology Department of the Iowa Agricultural College at Ames.

Dr. J. McDunnough has relinquished his position as curator of the Barnes collection, Decatur, Ill., to accept a position, April 1, in the Entomological Branch of the Department of Agriculture at Ottawa, Ont., Canada.

Mr. J. V. Ormond, of the Bureau of Entomology and C. C. Hamilton, extension entomologist of the Missouri College of Agriculture are just completing two months of successful work in organizing the beekeepers of Missouri.

Lieut. W. H. Larrimer of the Bureau of Entomology has returned from army service and resumed work at LaFayette, Ind., where he will be in charge of the field laboratory in place of Mr. J. J. Davis, who has been transferred to New Jersey.

Dr. H. M. Parshley has been promoted to an associate professorship in the Department of Zoology at Smith College, Northampton, Mass. He has also been appointed associate in field zoology at the Cold Spring Harbor summer laboratory.

Mr. Paul A. Mader, who was engaged in white pine blister rust scouting in Pennsylvania, and volunteered for service, and was stationed at Newport News in Sanitary Corps work, has returned to the Bureau of Economic Zoology at Harrisburg.

Mr. Kenyon F. Chamberlain has been appointed assistant in entomology at the Connecticut Agricultural Experiment Station, New Haven, Conn. Mr. Chamberlain was employed temporarily by the station during the summer and early fall of 1918.

Sergeant H. M. Fort has been discharged from military service where he was in charge of the Laboratory at the Base Hospital at Camp Gordon, Ga., and will take up special bacteriological investigations in entomology at the University of Missouri.

Prof. H. A. Gossard of the Ohio Station addressed the Paper Shell Pecan Growers' Association at Chicago, March 8. One other address was given the same evening by Mr. C. A. Reed of Washington, nut culturist of the United States Department of Agriculture.

Messrs. J. E. Graf and C. H. Popenoe, of the U. S. Bureau of Entomology, and at present engaged in eradicating the Sweet Potato Root Weevil in Baker County, Fla., were present at the meeting of the Florida Entomological Society held on the evening of March 3, 1919.

Mr. J. L. King, after seven months' service in the U. S. Army, has returned to the Pennsylvania Bureau of Zoology, Harrisburg, and will be engaged in fruit insect pest investigations at Chambersburg, Pa., where the bureau will maintain a field laboratory during the growing season.

Dr. Leonard Haseman and Instructor K. C. Sullivan, of the Department of Entomology of the Missouri University, are completing plans for taking a class of research students into the swamp sections of the state during the spring term, to study mosquito and malarial problems.

Mr. Albert Hartzell has been discharged from the army service where he was a corporal in the Infantry, and has resumed his position as instructor in the Department of Zoology and Entomology of the Iowa State College. Mr. Hartzell's name was omitted from the Roll of Honor.

Mr. W. H. Goodwin, formerly of the Ohio Agricultural Experiment Station, visited the Station, March 7. Mr. Goodwin has been employed in extermination work directed against the Japanese beetle at Riverton, N. J., but recently has been transferred to extension work in that state.

Prof. Lawrence Bruner, head of the Department of Entomology, University of Nebraska, is now on leave of absence in California in an effort to regain his health. He is now considerably improved. During his absence, departmental activities are in charge of Professor Myron H. Swenk.

Messrs. R. H. Hutchinson, E. R. Sasser and E. A. Back of the Bureau of Entomology have been designated as a committee to act in cooperation with a committee from the Bureau of Chemistry to investigate the possible utilization of poisonous gases used in warfare for fumigation against insects.

Dr. F. A. Fenton, formerly of the Bureau of Entomology and later fellow in zoölogy and entomology, Ohio State University, who has been recently released from military service, has accepted an appointment as research assistant in the Iowa Experiment Station and entered upon his duties there in March.

Mr. D. M. DeLong has returned to the Bureau of Economic Zoölogy, Harrisburg, Pa., after serving seven months in the Sanitary Corps at the Yale Army Laboratory School and at Camp Devens, Mass. He will be located during the summer months at the field laboratory of the above bureau at North East, Pa.

Capt. Herbert T. Osborn, who has been in military service since July, 1917, received his discharge in December and has been visiting the Osborn family in Columbus, Ohio, but will return to his position in the Entomological Division of the Hawaiian Sugar Planters' Association Experiment Station in Honolulu early in April.

Appointments in the Bureau of Entomology are announced as follows: R. V. Rhine, apicultural extension work in Kansas; Edward R. Jones, for work on tobacco insects; Richard T. Cotton, to study *Calandra* attacking corn; J. C. Furman, stored product insect investigations; R. F. Wixson, apicultural extension work, Virginia.

Mr. John J. Davis, in charge of the field laboratory of the U. S. Bureau of Entomology at West Lafayette, Ind., has been transferred to New Jersey, beginning May 1, where he will take up the work of eradicating the Japanese Beetle, *Popillia japonica* Newm, in coöperation with Dr. T. J. Headlee, state entomologist of New Jersey.

The following members of the Bureau of Entomology, and who entered military service, have been honorably discharged from the service and have been reinstated in the bureau: W. D. Whitecomb, C. H. Alden, R. W. Kelley, E. W. Scott, Dr. G. F. White, Capt. E. H. Gibson, A. C. Mason, Max Reeher, J. U. Gilmore, T. P. Cassidy.

The Entomological Department of Purdue University, LaFayette, Ind., will put on a short course in apiculture, of one week's duration, beginning April 7, 1919. Dr. E. F. Phillips of the U. S. Bureau of Entomology, and other noted apiculturists will take part in the discussions. The course is intended principally for commercial bee-men.

Mr. J. S. Houser made a trip through northeastern Ohio, March 13 to 15, to locate some orchards suitable for spraying experiments and to do some preliminary scouting for possible discovery of the European Corn Borer. Mr. Houser was called to Columbiana County as an expert witness in a case regarding a carload of wheat infested with insects.

According to the *Experiment Station Record*, at the New Jersey Station, the experimental cranberry investigations, including tests of fertilizers, drainage, and insect control have been summarized, and with these data as a basis a new project on various phases of cranberry culture has been begun in charge of C. S. Beckwith, assistant entomologist.

According to *Science*, "it is announced that *Genera Insectorum*, the great work describing all the genera of insects, published at Brussels, is to be continued. When the country was invaded in 1914, several parts were about to be published; these are to appear in 1919. The stock of the previously published parts was saved, and is now available."

A memorial service was held December 8, 1918, at the University of Chicago, for the late Prof. Samuel W. Williston, formerly professor of paleontology. The speakers were Prof. E. C. Case, University of Michigan, Prof. Stuart Weller of the Department

of Geology and Paleontology, and Prof. Frank R. Lillie, Department of Zoölogy, University of Chicago

Mr. J. R. Stear, formerly of the Ohio Agricultural Experiment Station, visited the Station, March 7. Mr. Stear has been mustered out of the military service and is spending some time with his parents at New Brighton, Pa. He is waiting to see if Ohio can give him fair treatment in way of salary before deciding whether he will resume work at the station.

A school for bee-keepers was held at Cornell University during the week of February 24 to March 1, under the direction of the Department of Entomology in coöperation with Dr. E. F. Phillips and George S. Demuth of the Bureau of Entomology at Washington, D. C. The attendance and interest were very gratifying. The total registration for the week was 145.

Mr. W. O. Hollister of the Bureau of Entomology, stationed at the field laboratory at West Lafayette, Ind., has resigned to return to the Davey Institute of Tree Surgery at Kent, Ohio, as entomologist of the Research Bureau. Mr. Hollister was connected with the Davey Institute for several years and joined the forces of the Bureau of Entomology during the war.

Mr. M. D. Leonard, who was formerly entomologist of the Erie Co. Laboratory of the Pennsylvania State College, has been appointed special field agent of the U. S. Bureau of Entomology. He will be stationed on Long Island to carry on extension work in the control of truck-crop insects in coöperation with the Department of Entomology at Cornell University.

Mr. H. H. Knight, formerly investigator in entomology to the Cornell University Experiment Station and who has been in command of a corps of men in the Photographic Section of the Aviation Service in France has returned to this country. He expects to receive his discharge in a few weeks and will then resume his investigations on the biology of the Miridæ (Capsidæ).

Prof. G. M. Bentley, state entomologist and pathologist of Tennessee, is secretary-treasurer of the Tennessee State Florists' Association, the Tennessee State Horticultural Society, the Tennessee State Nurserymen's Association, and the Tennessee Beekeepers' Association. These organizations all held their annual convention at Nashville, Tenn., January 28-31, 1919.

A Senate Bill appropriating fifty thousand dollars (\$50,000), with \$10,000 immediately available, for European potato wart disease control, has been introduced in the Pennsylvania Legislature. The economic zoölogist has quarantined four townships about Hazleton, Pa., with an area of approximately 120 square miles, and three local points outside this main infected area.

Dr. J. H. Montgomery, quarantine inspector, Florida State Plant Board, has gone to New Orleans, La., to confer with Messrs. Compere (California) and E. R. Sasser (Federal Horticultural Board) on account of the Black Fly (*Aleurocanthus woglumi*) situation. This aleurodid is not known to be present in the United States, but occurs as a severe pest of citrus and other fruit trees in the Bahamas, Cuba and Jamaica.

The Florida State Plant Board has arranged to furnish the farmers in Baker County with about one million weevil-free sweet potato draws, under condition that they bed none of their own potatoes, which are generally infested with the Sweet Potato Root Weevil (*Cylas formicarius*). This arrangement is part of the plan for exterminating the weevil from the infested part of this county. The plants are being grown by the Plant Board.

Prof. J. M. Swaine of the Canadian Entomological Branch and known for his splendid work on the Scolytid bark-beetles is at Cornell University completing his work for the doctor's degree. He expects to take his examination some time during the latter part of March. His thesis on the Canadian bark-beetles has already been published as Technical Bulletin No. 14, Parts I and II, by the Canadian Department of Agriculture, Entomological Branch, Ottawa, Canada.

The following Florida entomologists served as speakers during the Better Fruit Campaign, recently (February 10 to 26) conducted in Florida under the auspices of the University of Florida Extension Division, with cooperation of the State Plant Board and the U. S. Department of Agriculture: Wilmon Newell, plant commissioner; W. W. Yothers, Bureau of Entomology, U. S. D. A.; J. R. Watson, Florida Experiment Station; E. W. Berger, State Plant Board; 3,090 people were addressed during the campaign.

The following transfers have been made in the Bureau of Entomology: E. R. Selkregg, deciduous fruit insect investigations, temporarily to Federal Horticultural Board; A. O. Larson, to extension fruit insect work in Utah; A. H. Beyer, Columbia, S. C., to Wichita, Kans.; A. L. Ford, Kansas to Knoxville, Tenn.; Max Kishuk, Jr., to Wilmington, N. C.; A. D. Borden, to extension work in California; W. H. Goodwin, to extension work with fruit insects in New Jersey; Charles F. Moreland, from extension work to research on the sweet potato weevil.

Mr. A. C. Lewis, state entomologist of Georgia, announces that the Georgia State Board of Entomology has secured the services of Dr. D. C. Warren of Auburn, Ala., as assistant entomologist, with headquarters at Valdosta, Ga., to conduct dusting experiments for the control of the boll weevil. The State Board of Entomology conducted preliminary tests last year on this work. While the results secured were encouraging, they were not conclusive enough to make any recommendations in regard to dusting for the control of the boll weevil.

The electrical machine invented by F. S. Smith of Philadelphia for the control of insects in packages of cereals is now being installed in the factory of the Hecker Cereal Company of New York City. Tests made by Dr. Back and Mr. Smith, during November and December, showed a result of 100 per cent effectiveness in killing various cereal pests when these were introduced in "commercial numbers." The machine is of great promise and has awakened great interest among cereal concerns approached by its owners, M. E. Gillett and Son, of Tampa, Fla.

The following resignations from the Bureau of Entomology have been announced: E. L. Sechrist, bee culture to engage in commercial beekeeping in Haiti, where he will manage 2,000 colonies; H. G. Ingerson, grape insects, to accept a position at Ohio State University; J. F. Gardener, scientific assistant, cereal and forage crop insects, on account of ill health; R. H. Jung, John H. Moore, extension work; A. L. Johnson, inspector; J. U. Gilmore, southern field crop insect investigation; D. A. Ricker, cereal and forage crop insect investigations; A. B. Champlain, to accept a position with the economic zoologist, Harrisburg, Pa.; W. O. Hollister, to return to Davey Institute, Kent, Ohio.

Mr. Alfred B. Champlain, Bureau of Entomology, who has recently been in charge of a field station for the study of forest and shade tree insects at Lyme, Conn., under Dr. A. D. Hopkins, has been appointed scientific assistant and curator of the state insect collections at Harrisburg, Pa., under Prof. J. G. Sanders, economic zoologist. Mr. Champlain will have an opportunity for field work and biological and life-history investigations. He will retain his connections with the bureau as a collaborator.

Mr. Champlain started work in his new position March 1. He was formerly an assistant in the laboratory at Harrisburg, resigning some five or six years ago to accept a position in the bureau.

Prof. H. A. Gossard, Ohio Agricultural Experiment Station, attended a conference, March 4, of the entomological workers of the state at the office of the secretary of agriculture, to discuss ways and means of preventing the introduction of the European Corn Borer into Ohio, and of discovering its presence if it has already become established anywhere. A working cooperative program was arranged by which state-wide surveys will be made under the direction of the Bureau of Nursery and Crop Inspection, the entomologists of the Experiment Station and State University assisting. Secretary Shaw was to undertake securing from the Legislature, an emergency provision for handling any discovery of the insect that may be found.

The annual meeting of the entomological workers in Ohio institutions was held in the Botany and Zoölogy Building, Ohio State University, Columbus, Ohio, January 30, 1919, beginning at 9.30 A. M. The following papers were presented: Brief Addresses—Raymond C. Osburn, Head, Department of Zoölogy and Entomology, Ohio State University; H. A. Gossard, entomologist, Experiment Station; E. C. Cotton, chief, Bureau of Horticulture; H. A. Gossard—Timely Notes; Herbert Osborn—Further Notes on Meadow Insects; W. C. Kraatz—A Study of *Scirtes tibialis* Guer.; W. M. Barrows—Grassland Spiders, Stratification in Associations; Robert K. Fletcher—A Few Notes on the Miridae of Meadows and Pastures; D. C. Mote—Report on Anthelmintic Experiments; T. H. Parks—The Bioclimatic Law (Law of Altitude, Latitude and Longitude) as Applied to Hessian-Fly Control in Ohio; Edna Mosher—Some Interesting Beetle Larvæ; A. J. Basinger—Preliminary Studies in Ohio Tachinids; C. H. Young—Notes on *Tropisternus glaber* (Herbst); R. C. Osburn—The Onion Fly, *Eumerus strigatus*, in Ohio; J. S. Hine—The University Entomological Collections; J. S. Houser—An Undeveloped Profession.

The sixth annual meeting of the New Jersey Mosquito Extermination Association was held at the Chalfonte Hotel, Atlantic City, N. J., February 6 and 7, 1919. About one hundred and fifty attended the first session on Thursday evening of February 6 and listened to a very interesting address, "Mosquito Control about Cantonments and Shipyards," by La Price of the U. S. Public Health Service. The Friday morning session was a symposium on "Mosquito Control." The work of the season was presented in ten-minute papers by members of the New Jersey County Commissioners from twelve counties. Nearly every county has one or more special mosquito problems and the important points in the solution of these problems were discussed, making this session of special interest to mosquito workers present from other states. At the afternoon session several papers were presented dealing with the emergency mosquito work around military camps, shipyards and munition factories. Among the interesting papers were "Mosquito Eradication in Southeastern Pennsylvania," by Dr. B. Franklin Royer, acting commissioner, Department of Health, of Pennsylvania; "Mosquito Control in Military Camps," by Russell W. Gies, and Jesse B. Leslie, captains in the Sanitary Corps of the U. S. Army. The last session of the meeting Friday evening was devoted to "The Problem of Finishing the Mosquito Drainage of the New Jersey Salt Marsh." An able paper was presented by Dr. Headlee, "The Work Involved, Its Approximate Cost and Maintenance." Other interesting papers were presented covering the attitude and the part of the various state and municipal organizations interested in the work. The New Jersey Mosquito Extermination Association is by far the leading organization devoted to mosquito control work in the country. The membership is over 2,200 and the annual meetings should be attended by every anti-mosquito worker in the country.

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